SLUDGE DEWATERING STUDY

for

INTERMOUNTAIN POWER SERVICE CORPORATION

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By

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EXECUTIVE SUMMARY

The purpose of this study is to develop design and cost information to improve the process of dewatering sludge from the Flue Gas Desulfurization (FGD) system at the Intermountain Power Plant. An integral aspect of this goal is to consistently produce byproduct-grade gypsum for production of wallboard or other industrial products requiring gypsum. The study is motivated by the aging condition of the existing dewatering equipment along with the variable dewatering characteristics of the sludge now being produced.

The primary objective of the FGD process is to meet environmental control standards for sulfur dioxide emissions. This goal is now being achieved very well. However, the variable sulfur content of the coal makes it a challenge to consistently produce FGD sludge that is fully oxidized. Also, the primary variable for control of the sulfur dioxide emissions is the pH of the recirculating scrubber slurry. An increase in pH provides improved scrubbing, but higher pH reduces the oxidation rate by preventing the calcium sulfite in the sludge from dissolving, oxidizing and precipitating as gypsum. Consequently, the sludge produced has changing dewatering characteristics as the pH is adjusted for control of sulfur dioxide emissions. The percentage of gypsum (oxidized sludge) varies from about 65 to 95%, and this variation has a tremendous impact on the dewatering characteristics of the sludge.

When the sludge contains more calcium sulfite due to lower sludge oxidation, the sludge dewatering characteristics deteriorate, resulting in difficulties in dewatering operations. Consequently, the operators struggle to keep the thickeners operating with a clear overflow and to dewater the thickened sludge on the existing drum filters. On the other hand, when the sludge is fully oxidized, dewatering characteristics improve and the dewatering operations more consistently meet operating goals.

Another factor that influences dewatering operations is the quantity of sludge produced. The quantity of sludge produced has increased over the years due to a trend towards higher sulfur content of the coal and a higher coal firing rate. These changes can more than double the amount of sludge that the equipment was originally designed to handle. Consequently, the dewatering equipment is in need of upgrading to handle the larger quantity of sludge.

Although the main objective of this study is to improve the dewatering equipment and operation, its scope extends to the scrubbing system with the additional objective of providing tools for the scrubber operators to improve the dewatering characteristics of the solids produced.

The options available to improve dewatering operations are a combination of scrubber and dewatering equipment improvements. To work effectively, the improvements in the scrubbers must be consistent with the changes in dewatering equipment and procedures. Consequently, several option packages have been identified to achieve the objectives. Those identified here are not the only option packages, but sufficient information is provided to allow for selection of other combinations that might be considered. Four main options are discussed with some variations as follows:

Option Package I – Produce fully oxidized gypsum by either installation of a sodium formate system or (in option IA) by installing an external oxidizer, plus install new horizontal belt filters for production of wallboard quality gypsum. Option IB combines the use of sodium formate in the scrubbers with reconditioning of the existing filters rather than replacing them with new horizontal belt filters. Option Package I is specifically designed to give the operators another tool (sodium formate or an external oxidizer) to control oxidation rate along with control of SO_2 emissions. This additional tool is needed to provide full oxidation with the complete range of coal sulfur content and coal firing rates.

Option Package II – Allow oxidation rate in scrubbers to continue to swing between about 65 and 95% and refurbish existing dewatering equipment or replace existing equipment to reliably handle the variable sludge dewatering characteristics. This option does not give the operators any new tools or equipment to accomplish their goals. It only restores the existing equipment to near new condition and provides guidelines for operations to achieve their goals as efficiently as possible.

Option Package III – Install a new hydroseparator to split out calcium sulfite for recycle and to thicken and wash the gypsum that is produced. This option assumes that complete scrubber oxidation is feasible with minimal scrubber improvements and changes in operating procedures. This assumption has not been proven with existing operations and may not be achievable over the entire range of coal sulfur content. Option Package III is contrasted with Option Package I in that it does not provide the operators with another tool such as sodium formate or an external oxidizer to allow for complete oxidation under all coal sulfur conditions.

Option Package IV – Install a sodium formate system for oxidation rate control; install a hydroseparator for thickening and fines recycle; and install new horizontal belt filters to meet gypsum byproduct specifications. This is the complete package for the operators to meet desired goals under all operating ranges anticipated. This option package is easily integrated with dewatering operations for the future Unit 3 gypsum.

Note that all Option Packages require changing existing operations to go to near continuous operation of the dewatering equipment. This change is necessary to keep up with sludge production rates and to avoid degradation of performance due to accumulation of sludge when the filters are not in operation.

Within these three basic options, there are several alternatives. The main alternative included in Options I, IA, III and IV is to replace the existing vacuum drum filters, which are not well suited to dewatering gypsum, with horizontal belt filters, which have become the industry standard for producing byproduct gypsum. Options IB, II and IIIA assume that the filters will be reconditioned rather than replaced.

Table III, shown below, summarizes the estimated costs of the different options.

TABLE III
SUMMARY OF ESTIMATED COSTS

Option	Description	Capital, $	Operating Cost Change, $/yr
I	Gypsum sale, Sodium Formate, New Filters	$3,678,000	-$755,000
IA	Gypsum sale, External oxidizer, New Filters	$4,526,000	-$955,000
IB	Gypsum sale, Sodium Formate, Recondition Filters	$2,278,000	-$755,000
II	Base case - improve existing equipment and operations	$1,711,000	-$820,000
III	Gypsum sale, Optimize Oxid., Hydroseparator, New Filters	$3,980,000	-$1,455,000
IIIA	Gypsum sale, Optimize Oxid., Hydrosep., Recond. Filters	$2,580,000	-$1,455,000
IV	Gypsum sale, Formate, Hydroseparator, New Filters	$3,930,000	-$755,000

Operating cost savings are produced by all of the options through sale of gypsum and by reduction in costs for pond dredging. Other operating cost savings for eliminating the operation and maintenance of existing filter cake handling and landfilling, but these savings have not yet been quantified and accounted for in the above estimates.

Although Option II followed closely by Options IB and IIIA are the lowest-cost options, They are not considered the best options for long-term performance, because they rely on reconditioning of the dewatering equipment along with operating changes to be sufficient to reliably produce byproduct quality gypsum. While technically feasible, these options are not likely to produce the desired results over time for several reasons, including 1) the scrubber pH must be controlled over too narrow a range to achieve both high oxidation and high SO2 removal consistently and reliably; 2) the thickeners and filters, although reconditioned, are not the right type of dewatering devices to consistently meet specifications for byproduct gypsum; and 3) while the existing filters will be restored to good physical condition, they are inferior tools given to operations and have demonstrated deficiencies over time. This approach has failed in the past.

Options I, IA, III, and IV are technically strong, and will achieve the desired goals for the long term. They are the preferred options for an improvement project where everything is designed and installed together to meet objectives. Options III and IV can also be completed as staged projects completed in two or three phases. An example of how Option Package IV might be implemented is as follows: Phase one would be to install a sodium formate addition system and to convert the existing filter feed tank to a hydroseparator, which will function to separate the finer calcium sulfite particles from the coarser gypsum. The cleaned and thickened gypsum from the hydroseparator will then be dewatered to a more consistent product for landfill. The overflow fines from the hydroseparator will then be evaluated for recycle to the scrubbers or for purging from the process by blending with flyash. The cost estimate for this first phase calls for about \$1,410,000 in capital costs with operating cost savings of up to \$820,000 per year. The sodium formate would initially only be evaluated in extended tests along with the hydroseparator operating options to determine the annual costs and performance of the system. Therefore, the operating costs for sodium formate would not be incurred for continuous operation. Gypsum byproduct would be produced for evaluation. The existing vacuum drum filters would not be improved or replaced until after the evaluation of the first phase of the project.

If the first phase of the project is successful in achieving the desired objectives, the second phase of the project would be to finalize the contract for gypsum sale and to install horizontal belt filters to meet the gypsum specifications. The cost of this phase would be approximately \$2,650,000 plus there would be operating cost benefits that would be defined by the gypsum contract, which would produce revenues from gypsum sale to offset the capital investment. Contracts for sale of gypsum at other plants have provided \$3 to \$10/ton of gypsum, which would generate up to \$635,000 to \$1,900,000 per year in revenues for IPP. However, this is a complicated negotiation that may involve a single potential customer, USG Corp. for their plant near Sigurd, Utah. Negotiated prices are likely to involve other terms of benefit to both IPP and USG, and are difficult to predict at this time.

The benefits of completing the entire project at once are that projected operating benefits and cost savings are realized immediately with improvements in both scrubber operations and in dewatering of the sludge. If the projected capital cost of about \$4,000,000 can be justified by the potential operating cost savings of up to \$1,500,000 per year, Option III appears to be a good option. However, the additional tool of having a feed system of sodium formate may be necessary to ensure that full oxidation can be achieved along with good SO_2 compliance under all conditions, as included in Option Package IV. This option provides for replacement of both the thickeners and the filters for long-term system reliability, although at least one thickener is retained as a fine solids thickener. Actual sodium formate usage would have to be studied to determine how often it is needed and the annual costs of such usage.

One of the benefits of using either Option Package III or IV is that they can be integrated easily with the gypsum produced in the future Unit 3 scrubbers, which scrubbers will most likely produce gypsum and will have hydroclones installed to produce a thickened underflow similar to what will be produced by the hydroseparator for Units 1 & 2. In fact, a hydroseparator could be installed for Unit 3 sludge thickening instead of hydroclones, if the new hydroseparator for Units 1 & 2 proves successful. The hydroclone or hydroseparator underflow from Unit 3 can be sent to the existing dewatering building for filtration on the new horizontal belt filters along with the sludge from Units 1 & 2. An additional horizontal belt filter will probably have to be added in the filter building to handle the additional gypsum from Unit 3. Another option would be to install enough filtration capacity when the Unit 1 & 2 horizontal belt filters are added to handle the additional gypsum from Unit 3. The quantity of sludge from all three Units could be handled on one filter (plus one spare) if the filters are sized for this option.

INTRODUCTION

The scrubbing system at the Intermountain Power Plant has a dual function of removing sulfur dioxide from the flue gas and also producing a waste material that is dewatered and placed in a landfill. The dewatering system consists of a series of tanks and pumps to manage the sludge plus three thickeners, three vacuum filters, and a pugmill system to mix the dewatered filter cake with flyash. The resulting mixture of scrubber solids and ash is then placed in a landfill. In addition, the Wastewater Holding Basin receives the scrubbing liquor, mostly thickener overflow. The liquor is pumped back to the scrubbing system as needed for liquid scrubbing operations.

Over the years changes in the amount of coal and the coal quality have placed additional burdens on the dewatering system. Also, a forced oxidation system was installed to improve scrubber chemistry and operation by oxidizing the majority of the absorbed sulfur dioxide. As a result, the quantity of scrubber sludge has increased, and the sludge solids consist mostly of gypsum ($CaSO_4 \cdot 2H_2O$). The dewatering equipment has also deteriorated over the years. Consequently, the performance of the dewatering system is no longer considered acceptable due to several deficiencies, including:

1. The filters struggle to keep up with the quantity of sludge produced and often produce a much wetter filter cake than desired;
2. The thickeners often produce an overflow that contains much of the smaller sludge particles rather than clear liquor, and the sidewalls of the thickener tanks are corroding through;
3. The Wastewater Holding Basin fills with scrubber solids and must be periodically dredged to recover pond volume;
4. The pug-mill system does not operate efficiently and produces dust that sometimes fills the filter building and surrounding area;

The performance of all of the major pieces of equipment in the dewatering area have degraded from the original results and are in need of significant maintenance and/or replacement to achieve reliable, long-term performance. This physical condition of the equipment, the increased quantity of sludge, and deteriorated performance results combine to provide the incentives for this dewatering study. In addition, the technology of FGD gypsum dewatering has matured over the years, and there is a need to match the dewatering characteristics of the scrubber sludge with the right dewatering equipment for long-term reliability and performance. There may also be an opportunity to sell the gypsum as a byproduct and eliminate the long-term on-site disposal requirements for the sludge.

This report reviews existing dewatering equipment and dewatering operations. Then, through a study of the dewatering characteristics of the sludge along with application of existing gypsum dewatering technology, develops a plan to improve existing sludge dewatering operations. Preliminary cost information is also presented for budgeting purposes.

OPERATING & DESIGN OPTIONS

A preliminary review of sludge dewatering operations identified several dewatering options for consideration, including:

Option Package I – Produce saleable gypsum and install dewatering equipment consistent with typical dewatering for wallboard quality gypsum.

1. Improve oxidation in scrubbers to meet wallboard quality, i.e., consistently over 95% gypsum;
2. Install permanent storage and delivery system for sodium formate or dibasic acid (DBA) to handle excursions in SO2 scrubbing without reducing oxidation rate;
3. Install hydroclones or a hydroseparator for thickening and abandon existing thickeners;
4. Install new horizontal belt filter(s) and abandon existing vacuum filters;
5. Purge non-gypsum fines (hydroclone overflow) to pond or use to wet flyash for disposal;
6. Secure a contract for sale of gypsum
7. Implement design options for out-of-spec gypsum recycling or disposal.

Option Package IA – Same as Option Package I, but separate the scrubber operation from dewatering by installing a new external oxidizer(s) to ensure the solids sent to dewatering are consistently over 95% gypsum.

1. Install new external oxidizer(s) near existing scrubber buildings
2. Use excess from existing oxidation air compressors for new oxidizer(s)
3. Install sulfuric acid storage and handling for pH control
4. Install hydroclones or hydroseparators near new oxidizer
5. Recycle hydroclone or hydroseparator underflow to oxidizer for gypsum particle size control
6. Pump hydroclone underflow to new horizontal belt filter and pump overflow to recycle and/or to fly ash wetting and to disposal pond.

Option Package IB – Same as Option Package I, but with reconditioning existing drum filters rather than installing new horizontal belt filters.

Option Package II – Allow oxidation rate in scrubbers to continue to swing between about 65 and 95% and improve existing equipment or install new equipment to handle the sludge reliably.

1. Measure dewatering characteristics of sludge covering the design operating range of oxidation rates now being experienced;

2. Evaluate need for permanent storage and delivery system for sodium formate or DBD to handle excursions in SO2 scrubbing to minimize swings in oxidation rate and dewatering characteristics;
3. Install new thickener(s) designed to handle a range of settling rates and with the capacity in rake design and sludge storage consistent with vacuum filtration cycles.
4. Redesign underflow pumping and handling to avoid damaging crystals and to ensure that underflow or fines in overflow will not be sent to the Wastewater Holding Basin;
5. Recondition existing vacuum filters, conveyors and pug mills to eliminate dust and to operate reliably over the range of dewatering characteristics. Replace filters if necessary;
6. Adjust operating cycles for the filters to be consistent with overall design of the thickener/filter operating system.

Option Package III – Improve scrubber oxidation to consistently provide a higher percentage of gypsum as considered economically feasible. Install a new hydroseparator(s) to split out calcium sulfite for recycle and/or separate dewatering.

1. Measure dewatering and hydroseparation characteristics of sludge covering the design operating range of oxidation rates now being experienced;
2. Install hydroseparator(s) with washed underflow (gypsum) going to new horizontal belt filter(s) and recycle overflow for further oxidation and/or send to new or reconditioned thickener and new vacuum filters.
3. Recycle the separated fines from the hydroseparator back to the scrubbers for oxidation of calcium sulfite and for growth of gypsum fines.
4. Optimize existing oxidation system and scrubber operations for consistent minimum performance compatible with findings.

Option Package IIIA – Same as Option Package III, but with reconditioning existing drum filters rather than installing new horizontal belt filters

It was decided to first review the performance of the thickeners and filters along with the characteristics of the sludge produced by the flue gas desulfurization (FGD) process. The results would then be use to evaluate each of the above options.

Option Package IV – Install a sodium formate system for oxidation rate control; install a hydroseparator for thickening and fines recycle; and install new horizontal belt filters to meet gypsum byproduct specifications. This option package combines the best aspects of the other three options into a single package that can be developed in phases or all at once, depending on capital budgets and byproduct gypsum negotiations.

EVALUATION OF EXISTING FILTERS AND THICKENERS

On February 1, 2006 engineers from WesTech Engineering and Codan Associates observed the filter and thickener operation during the night shift. Samples were collected of the sludge being processed at the various stages of the dewatering operation. At the time, the 'A' and 'C' thickeners were operating along with one vacuum filter. The following is a summary of the observations and measurements:

THICKENERS

Feed Slurry to the thickeners measured 8.4 wt.% solids (compared to operating goal of about 15% solids in the scrubbers)

Thickener overflows measured as follows:
'A' thickener overflow = 217 ppm suspended solids
'C' thickener overflow = 36 g/l suspended solids (3.4 wt.% solids)

Thickener underflow slurry (filter feed tank) measured 41 to 43 wt.% solids

Gypsum slurries are typically dewatered by hydroclones rather than gravity thickeners. When gravity thickeners are used, they must be operated with a minimum of inventory to avoid classification of the solids and underflow densities that are too difficult to pump. Consequently, the existing gravity thickeners are not well suited to handle the gypsum being produced in the scrubbers, especially if the oxidation rate varies, giving variable requirements for thickening. This is especially true if the solids are recycled to the thickeners, destroying the effects of flocculation and overloading the capacity of the thickeners to process the total amount of solids going to the thickeners.

Another significant limitation of the existing thickening system is the size of the filter feed tank. It can store about 7,200 gallons per foot of depth. The sludge production rate at 45% solids is about 16,000 gallons per hour with 1% sulfur coal. If the active volume of the filter feed tank is about 15-feet, only about 6.8 hours of sludge storage is available between filtration cycles. The filters must, therefore, be operated at least every 6 to 7 hours to process all of the sludge being produced in the system.

Based on our observations and laboratory test results, we would strongly recommend the following adjustments to thickener operating practices:

1. Eliminate solids recycle because it causes solids to overflow to ponds;
2. Monitor thickener overflow and take corrective action to improve flocculation or reduce inventory of sludge to correct problems with solids in overflow;
3. Once the underflow solids concentration reaches about 45 to 50 wt.% solids, the underflow slurry should be pumped to the filter feed tank and not be returned to the thickeners;
4. Operate the vacuum filters either continuously or with no more than 6 – 7

hours between filter cycles to keep up with sludge production rates with up to 1% sulfur coal being burned.

The thickeners appear to be operating well mechanically. The thickener overflow tank is full of sludge solids from operation with dirty thickener overflow. This tank should be cleaned and should remain clean if the thickeners are operated correctly. Any problems with corrosion of the tank sidewalls should be corrected by patching and/or protection with coatings, eliminating the soil against the tank wall, and/or anodic/cathodic protection.

VACUUM FILTERS

On 2-1-06 the sludge filtration rate was measured at about 87 lb/hr/ft2, or about 30 tons/hr of sludge solids per vacuum filter. The sludge production rate from the combined generating units is 41 tons/hr (continuous operation) when burning 1% sulfur coal. Therefore, continuous operation of one vacuum filter plus intermittent operation of a second is required to keep up with the sludge production rate. Current operating practice is to operate the vacuum filters only during the night shift, which gives too many hours between filtration cycles to handle all of the sludge produced, if the percent sulfur in the coal being burned is higher than about 0.4 to 0.5%. This may be one of the primary reasons that the thickeners are put into recycle, which then causes the excess sludge solids to overflow the thickeners to the Wastewater Holding Basin.

One 2-1-06, the filtration rate was limited by the low vacuum levels, filtrate remaining in internal piping (blowback into cake), uneven cake thickness (0.25 to 0.75-inch), cloth blinding and partial cake discharge. The filter cake was very sloppy, and the samples collected measured 77 wt.% solids.

One filter would be capable of up to 50 tons/hr of sludge solids filtration (rather than the observed 30 t/hr) if the condition of the cloth and filters were improved.

Filters need to be gone over completely for mechanical checks:

1. Determine why filtrate is not being pulled out effectively to the receivers;
2. Replace cloths more frequently to eliminate blinding condition (evaluate other cloths that might last longer without blinding.) Periodic high-pressure cloth washing may help reduce blinding;
3. Evaluate condition of filter valve and low blowback effectiveness;
4. Determine mechanical condition of vacuum pumps and capacity. Recondition if necessary.

Other changes are suggested by the laboratory test results presented later in this report.

LABORATORY TEST RESULTS

Samples of sludge were collected on two occasions to evaluate properties of the solids being produced in the scrubbers. The first sampling occurred on February 1, 2006 when the slurries in the thickener feed tank, thickener, filter feed tank and filter discharge were sampled as reported above. Some of these samples were studied in the lab for settling and filtration characteristics. The second sampling occurred on March 31, 2006 when all of the operating scrubbers were sampled at the scrubber reaction tank overflow and at the pH pots. Detailed results of the laboratory results are attached in the Appendix.

SLUDGE CHARACTERISTICS

The purpose of the second set of samples was to thoroughly characterize the range of solids dewatering characteristics from the operating scrubbers. This was done by measuring the chemical composition and particle size distributions of the samples. Table I is a summary of these results, while more details are found in the Appendix.

TABLE I

IR ANALYSIS AND PARTICLE SIZE INFORMATION OF SCRUBBER SOLIDS

SAMPLE ID*	GYPSUM (WT%)	CaSO3 (WT%)	CaCO3 (WT%)	Oxidation mole %	Mean PSD	D10 PSD	D90 PSD
U1B-O	61.5	34.0	2.5	57.6	38.0	3.7	87.5
U1B-P	66.5	29.0	2.5	63.2	36.8	3.7	84.8
U1C-O	60.5	35.5	2.0	56.1	29.7	4.4	77.7
U1C-P	59.5	36.0	3.0	55.3	33.3	4.6	83.2
U1D-O	54.5	42.0	1.0	49.3	33.6	4.5	81.3
U1D-P	68.0	27.0	3.0	65.4	36.1	4.9	85.3
U1E-O	62.5	34.0	2.0	58.0	34.4	4.7	82.8
U1E-P	64.0	32.0	2.0	60.0	32.3	4.4	80.2
U2A-O	65.0	29.5	3.5	62.3	36.9	2.3	86.8
U2A-P	68.5	26.5	2.5	66.0	41.4	2.5	88.0
U2C-O	73.0	23.5	1.0	70.0	38.8	3.0	86.9
U2C-P	79.5	17.0	1.5	77.8	49.8	3.9	89.7
U2D-O	97.0	1.0	0.5	98.6	63.2	34.3	94.4
U2D-P	96.5	1.0	1.5	98.6	65.5	36.2	97.3
U2F-O	76.0	21.0	1.5	73.1	44.0	4.3	94.8
U2F-P	71.5	25.0	1.5	68.2	44.5	4.3	94.7
Averages	70.3	25.9	2.0	67.5	41.1	7.9	87.2

*Sample ID includes Unit number, Module letter and either overflow (O) or pH pot (P)

Oxidation

Notice that the average oxidation rate for the samples in Table I is only 67.5% and that only the 2D scrubbing module had essentially full oxidation of the sludge particles. The lowest oxidation rate in module 1D was just under 50% in the overflow sample. In general, the oxidation rate in the Unit 2 scrubbers was higher than Unit 1 scrubbers, and the pH pot samples were generally more oxidized (4 percentage points on the average) than the overflow samples. Even though the reaction tanks are well agitated, the coarser, oxidized particles tend to accumulate near the bottom of the reaction tank, while the finer, unoxidized solids tend to preferentially overflow the reaction tank.

At the time of the sampling, the scrubbers were being operated at a pH of 5.8 to 5.9. When the samples were received in the lab, all of the samples had a pH of 6.1 to 6.2 except for sample 2D, which measured 5.8, indicating that the best oxidation rate was achieved at a lower pH of operation. This result is consistent with known properties of calcium sulfite, which will dissolve and oxidize faster at lower pH. It is thought that a major cause of poor oxidation rates is that the pH is too high in the reaction tank to allow the calcium sulfite to dissolve rapidly enough to oxidize and precipitate as gypsum. Most limestone scrubbers with forced oxidation operate at a pH range of 5.0 to 5.5 to ensure complete oxidation. However, the mass transfer characteristics of the scrubbers must be capable of achieving SO2 removal compliance while operating at the lower pH range, which is not the case with the current scrubber design.

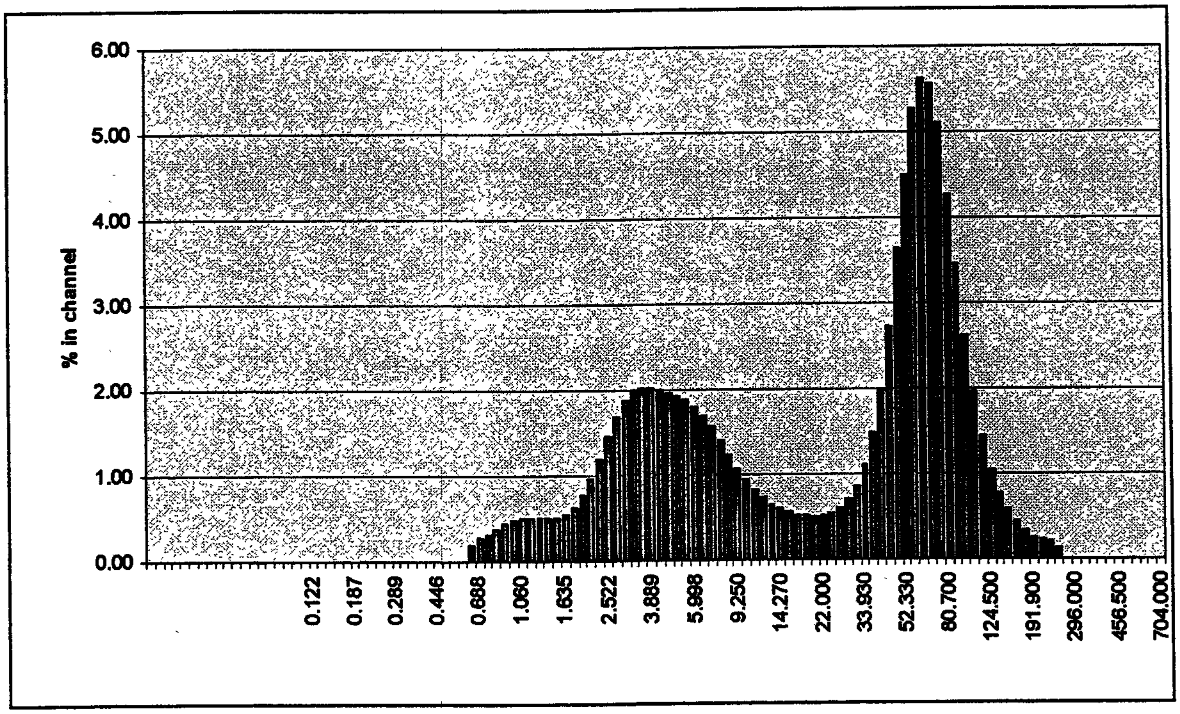
The high pH is not causing a problem with limestone concentration in the solids, which averaged 2%. The relatively long residence time for solids in the reaction tanks and the limestone grinding system are providing for good limestone utilization under the operating conditions in the scrubbers.

The suspended solids concentrations of the scrubber samples averaged 12.7% with a range of 9.3 to 15.2. Also, the pH pot samples averaged nearly 2 percentage points higher than the overflow samples, again indicating that there is still some classification going on in the reaction tanks. It appears that the suspended solids concentrations are generally lower in the overflow than indicated by the density meters, most likely due to classification of the solids, which gives lower solids concentration in the overflow than is being recycled through the pumps. It is also possible that some dissolved solids are being counted as suspended solids during density meter calibration, which would lead to lower actual suspended solids concentrations in the recycle slurry.

Particle Size & Shape

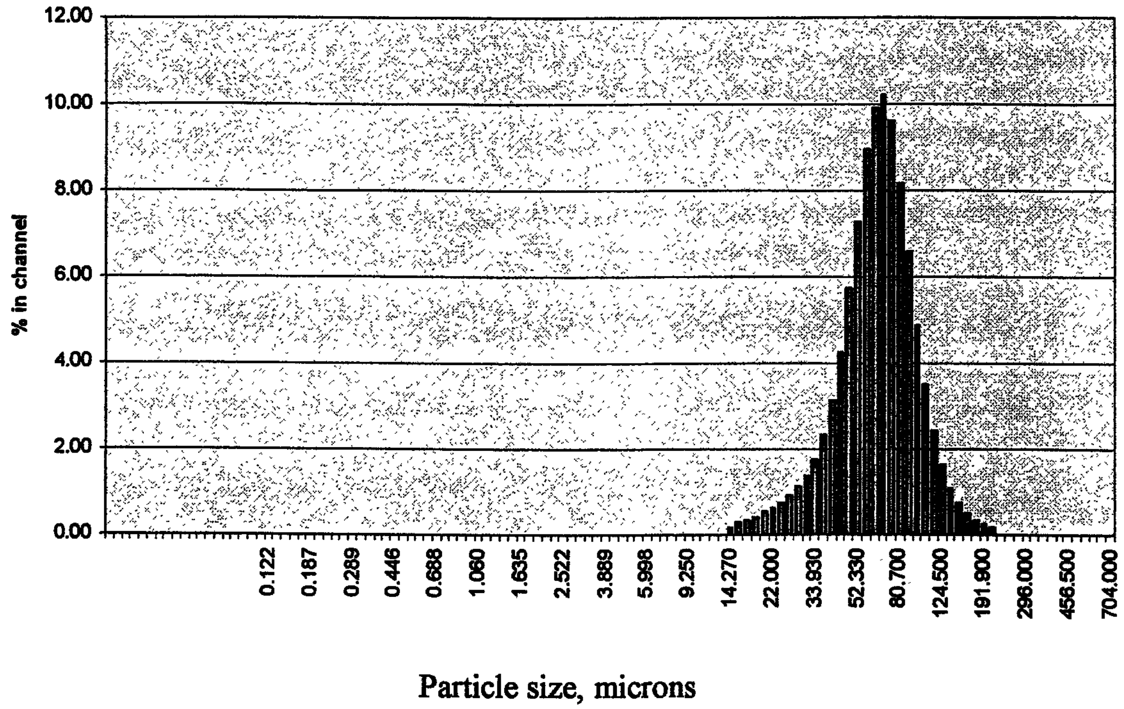
The particle size distributions indicate that all of the samples, except the fully-oxidized samples from module 2D, show a bimodal PSD. Figures 1 and 2 are good examples of the bimodal distribution from sample U2A-P and the fully oxidized sample U2D-P. Notice that the unoxidized sample U2A-P has a peak at about 75 microns for the gypsum particles and at about 4 microns for the sulfite particles and finer gypsum solids. The oxidized sample U2D-P has a single peak at about 75 microns. The goal of the scrubber oxidation system is to produce a particle size distribution like module U2D-P, because the coarser solids dewater at a faster rate to a higher cake solids concentration. Consequently, the dewatering system can keep up with the production rate of solids much more easily, and the final filter cake can be sold as byproduct, or if not sold, needs no fly ash mixed with it to make it handle well for placement in the landfill. The presence of calcium sulfite in the solids also eliminates the option of producing byproduct gypsum for sale.

FIGURE 1
PARTICLE SIZE DISTRIBUTION – SAMPLE 2A-P



Particle size, microns

FIGURE 2
PARTICLE SIZE DISTRIBUTION – SAMPLE 2D-P (fully oxidized)



Scanning Electron Micrographs (SEM) were also made of a few samples to illustrate the shape and relative quantities of the sulfite and gypsum particles. Figure 3 is the SEM for Sample U2A-P showing the larger gypsum particles covered with the calcium sulfite platelets. The small size of the calcium sulfite makes dewatering very difficult, but the flat shape also adds to the dewatering difficulties. The high surface area of the sulfite particles adds to the amount of water retained when these particles are filtered. Contrast the particles in Figure 3 with those in Figure 4, which is a similar SEM of sample U2D-P. Notice how clean the particles are in Figure 4, and it can be imagined how much better the dewatering characteristics would be for this sample.

FIGURE 3
SEM OF SAMPLE U2A-P AT ABOUT 750 MAGNIFICATION

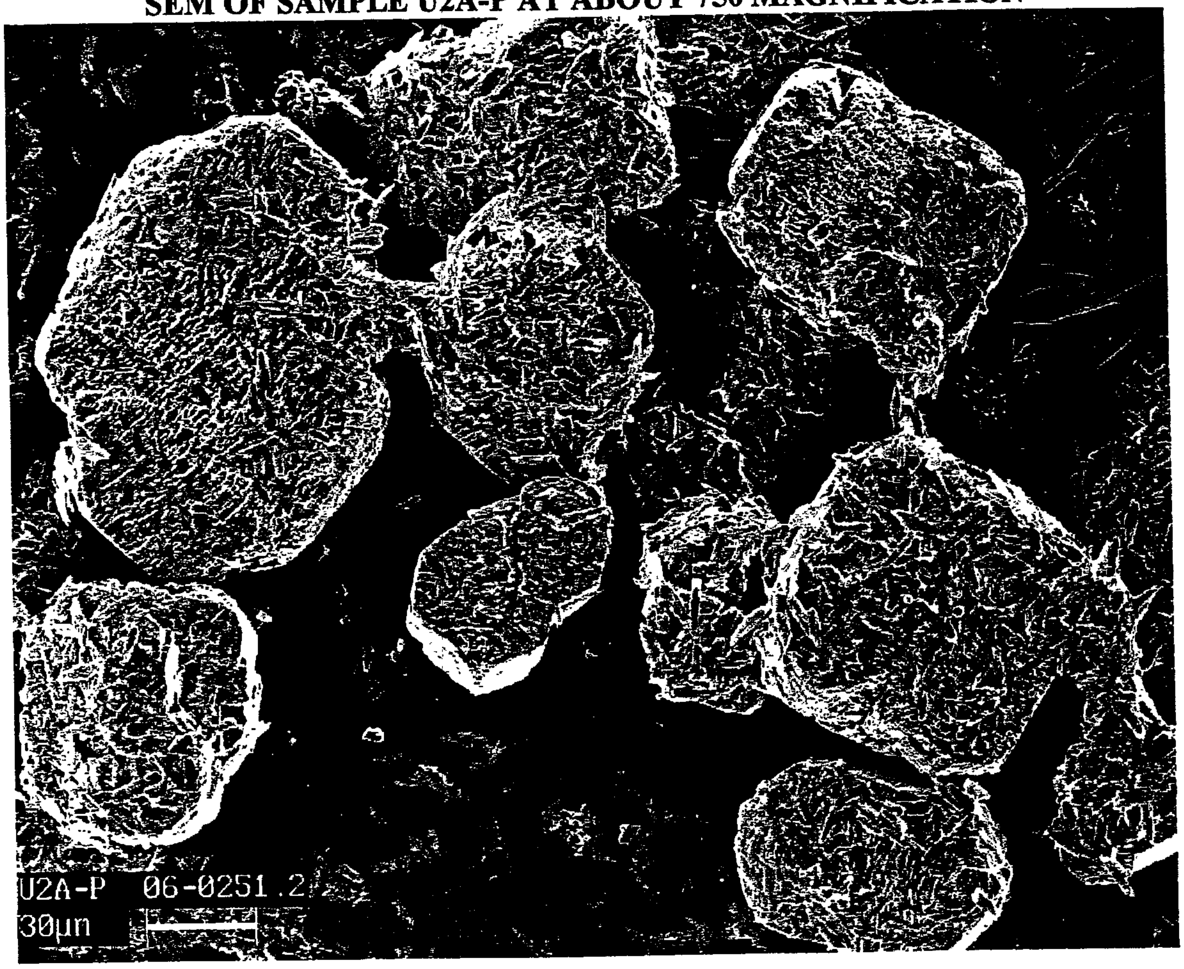
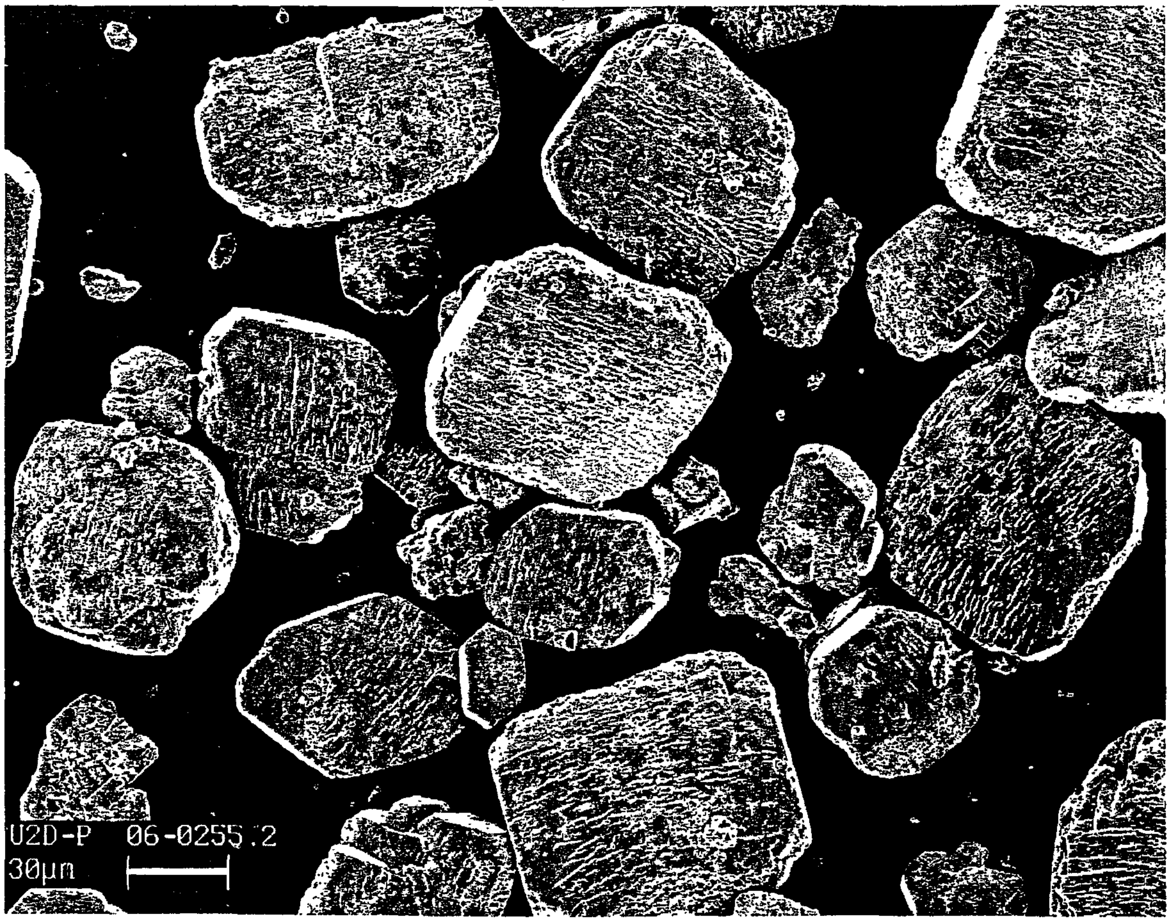


FIGURE 4
SEM OF SAMPLE U2D-P AT 750 MAGNIFICATION



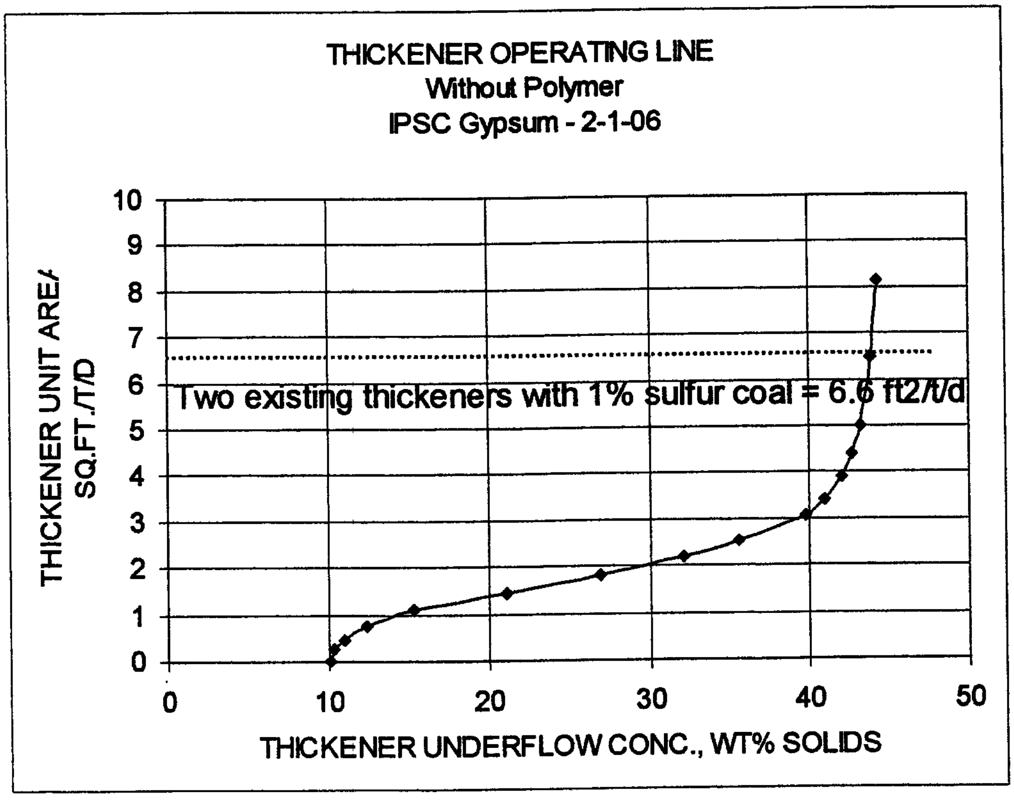
SETTLING TEST RESULTS

The settling tests were run in 2-liter cylinders with rakes to minimize the wall effects. The settling rate was recorded as a function of time both with and without polymer. The results were correlated by the Wilhelm-Naide Technique (see "Sizing and Operating Continuous Thickeners," J.H. Wilhelm and Y. Naide, Mining Engineering Magazine, December, 1981.) with depth correction to extrapolate the results to the size and depth of the full-scale thickeners.

The thickener operating curves predicted for the full-scale thickeners is shown in Figures 5 and 6, where thickener unit area is plotted as a function of underflow concentration for the two test conditions. The curves show that the full-scale thickeners should produce an underflow concentration of about 43 wt.% solids without polymer and about 57 wt.% solids with polymer while operating at the design production rate of solids and dividing the flow evenly between the two operating thickeners. The unit area of 6.6 ft2/t/d is calculated from full-load operation of the two generating units with 1% sulfur in the coal. The fact that the filter feed tank contained solids measured at 41 to 43% indicates that the solids were not being well flocculated in the full-scale thickeners. This is probably due to the recycle of thickener underflow that was being done at the time. The recycled underflow is not re-flocculated with polymer, and the effects of flocculation are largely destroyed by pumping at the high settled concentrations. Further evidence of the lack of effective flocculation was the high concentration in the 'C' thickener overflow at 3.4 wt.% solids.

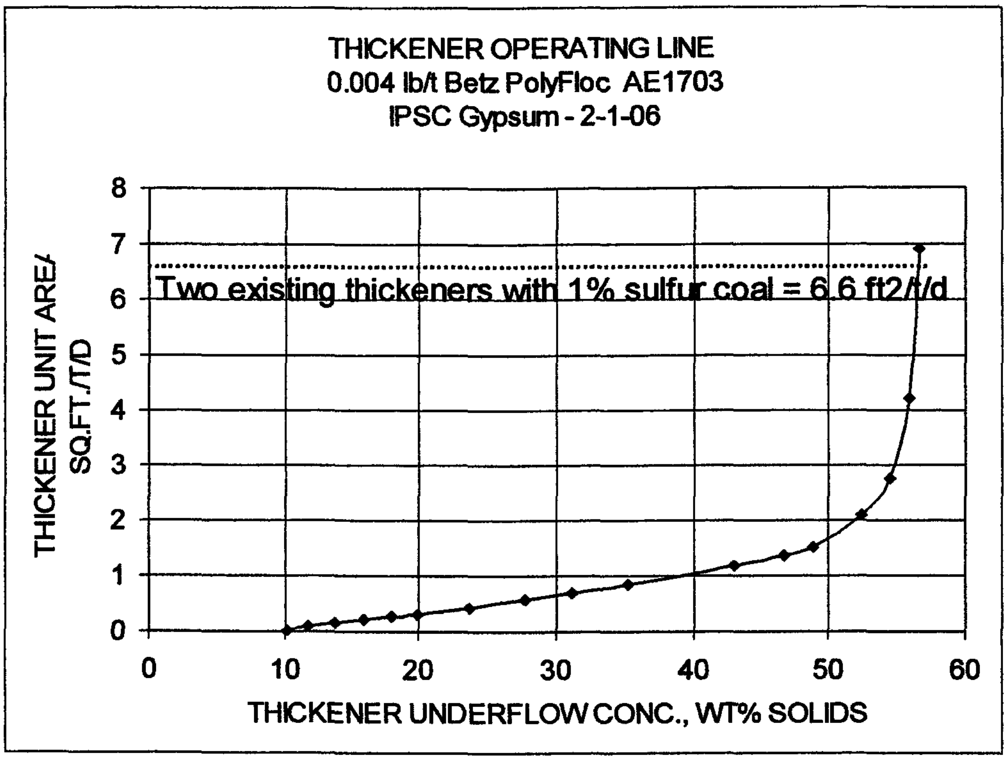
The shape of the operating lines in both Figures 5 and 6 indicates that underflow concentrations above about 43% without polymer and 58% with polymer are unlikely. Also, when polymer is added effectively to flocculate all of the solids going into the thickeners, all of the sludge could easily be handled by one thickener as long as the solids are not recycled. The practice of recycling thickener underflow back to the feedwell of the thickener has a significant negative impact on thickener performance, since it increases the loading rate of the thickeners and since the solids are not re-flocculated. The result is a high concentration of suspended solids, mostly smaller particles, in the thickener overflow.

FIGURE 5



IP12_000640

FIGURE 6



FILTER LEAF TEST RESULTS & CONCLUSIONS

Samples of thickener underflow from the filter feed tank were collected on 2-1-06 and tested in the lab to determine filtration characteristics. Another batch of scrubber samples were taken on 3/31/06 from the overflow and pH pot of each of the eight operating scrubber modules. These samples were thickened and used for laboratory filter leaf tests also, because they contained all of the fines. The samples from the operating thickener system were known to have some of the fines removed, since the thickener overflow from the 'C' thickener contained 3.4 wt.% solids. The measured filtration rates depend on cake solids concentration desired, degree of oxidation, and whether polymer is used.

Figures 7 and 8 present the filtration test results from the original samples collected on 2-1-06 from the filter feed tank. The results agree with the full-scale filter operation using the unflocculated results from the laboratory tests. If the samples are flocculated or if the fines are removed by hydroseparation, the filtration characteristics improve significantly. The quality of the cake for stacking and handling also improves dramatically.

FIGURE 7

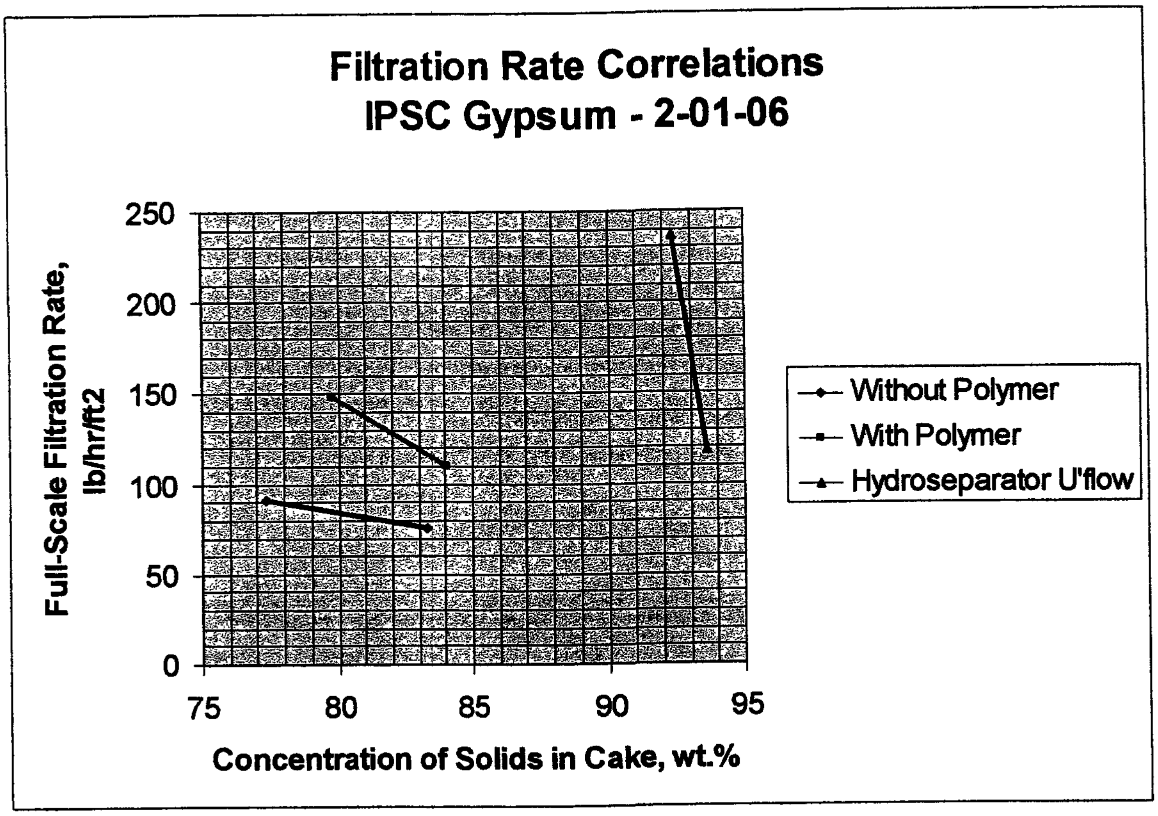
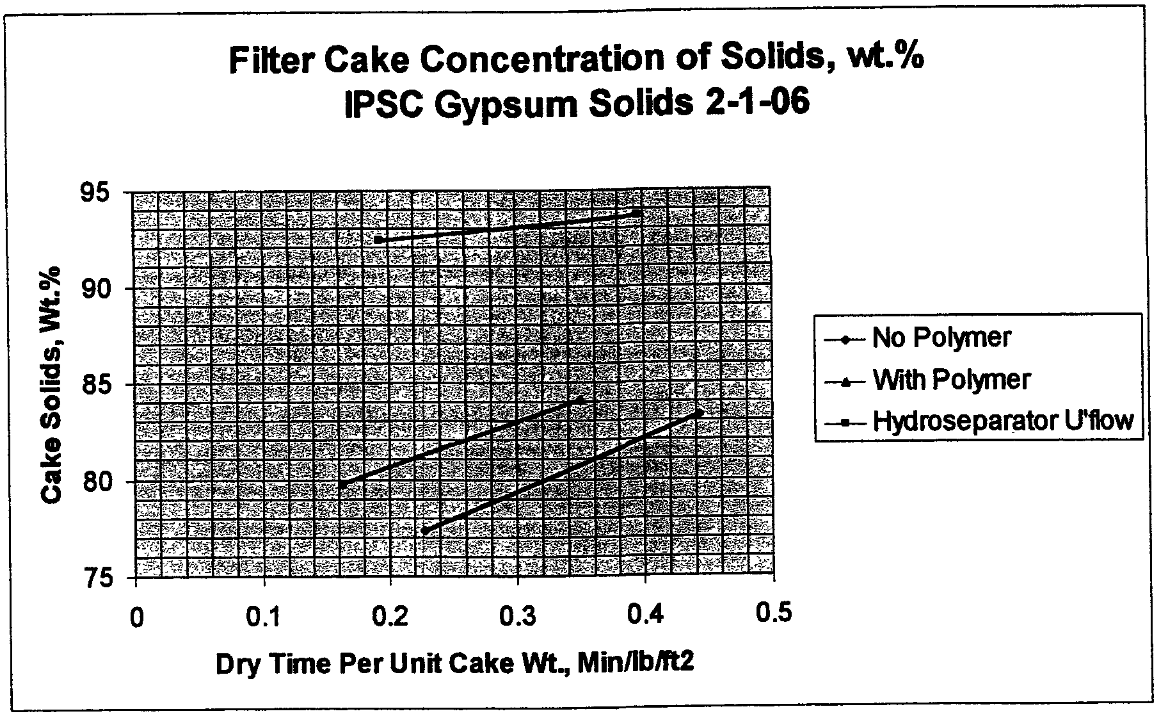


FIGURE 8



Unfortunately, these results are based on solids that had gone through the full-scale thickener system, which was removing many of the fines from the solids by overflowing suspended solids. The testing on the samples from the modules on 3-31-06 do not show such favorable filtration rates nor percent solids in the cake. These tests showed filtration rates ranging from 15 to 90 lb/hr/ft2, with an average of 32 lb/hr/ft2. Cake solids concentrations ranged from 65 to 80 wt.% with an average of 68 wt.% solids. Using the average filtration rate of 32 lb/hr/ft2, each vacuum filter would only be able to dewater about 11 tons/hr of sludge solids without polymer or about 20 tons/hr with polymer.

These results indicate that all three vacuum filters operating without polymer would not be able to keep up with sludge production even if they were all operated 24 hours/day. With polymer, it would take two filters operating 24 hours per day to keep up with sludge production rate with 1% sulfur coal. These results would improve significantly with improvements in the oxidation rate in the scrubbers.

HYDROSEPARATOR

Another method of improving effective oxidation rates and subsequent dewatering characteristics is to use a hydroseparator. The hydroseparator is a device that classifies the solids by settling rate using a rising column of liquid. In this case, the goal would be to remove the slower settling solids that are smaller than about 30 to 35 microns and to recycle them to the scrubbers to allow them to oxidize. The coarser gypsum solids would then be dewatered for disposal or as a byproduct for sale.

Laboratory hydroseparator tests were run to determine the sizing basis for a hydroseparator for the incompletely oxidized samples coming from the scrubbers. It was found that a rise rate of 3.73 inches per minute (2.32 gpm/ft2) would separate the particles at a cut size of about 35 microns. Depending on the percent oxidation, the overflow would then contain between about 24 and 47% of the solids, which would be the finer fraction. The coarser fraction would then have much better filtration characteristics.

To evaluate the hydroseparator sizing and performance for a range of solids oxidation rates from the scrubbers, two composite samples were prepared. The first was a composite of four scrubber samples with the highest concentration of small particles. This composite came from U2A-O, U2C-O, U1B-P and U1C-P. An equal volume of slurry from each of these samples was mixed to provide the feed to the hydroseparator test. The second test was done with a composite of four scrubber samples with the highest percentage of coarser particles. This composite was an equal volume of slurry from modules U2D-P, U2C-P, U2D-O, U2F-P. Table II is a summary of the hydroseparator tests made on these composite samples.

Note that there is considerable difference between the two feed slurries and the results in the overflow and underflow slurries. The composite of finer samples gave a mean particle size of just 29.6 microns and an oxidation rate of just 64.4%. The coarser composite had a mean particle size of 62.7 microns and an oxidation rate of 85.8%.

Table II
Summary of Hydroseparator Test Results

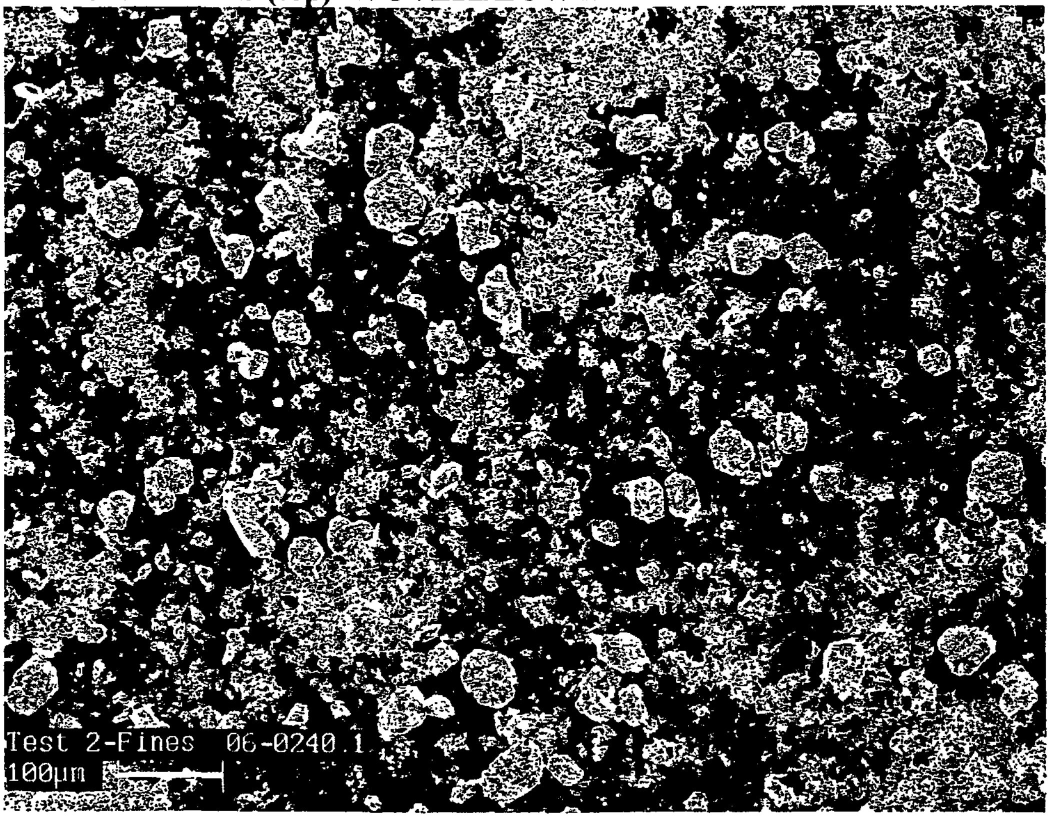
SAMPLE ID*	GYPSUM (WT%)	CaSO3 (WT%)	CaCO3 (WT%)	Oxidation mole %	Mean PSD	D10 PSD	D90 PSD
Fines Test 1-Feed	67.5	28.0	2.5	64.4	29.6	4.33	70.16
O'flow FINES	53.0	42.5	2.5	48.3	19.71	3.15	51.39
U'flow Coarse	87.0	8.5	2.5	88.5	62.73	10.8	100
Coarse Test 2 - Feed	86.1	11.0	1.3	85.8	55.75	19.675	94.025
O'flow FINES	66.5	28.5	2.5	63.6	24.7	2.72	51.4
U'flow Coarse	96.0	1.0	2.0	98.6	65.77	44.47	89.1

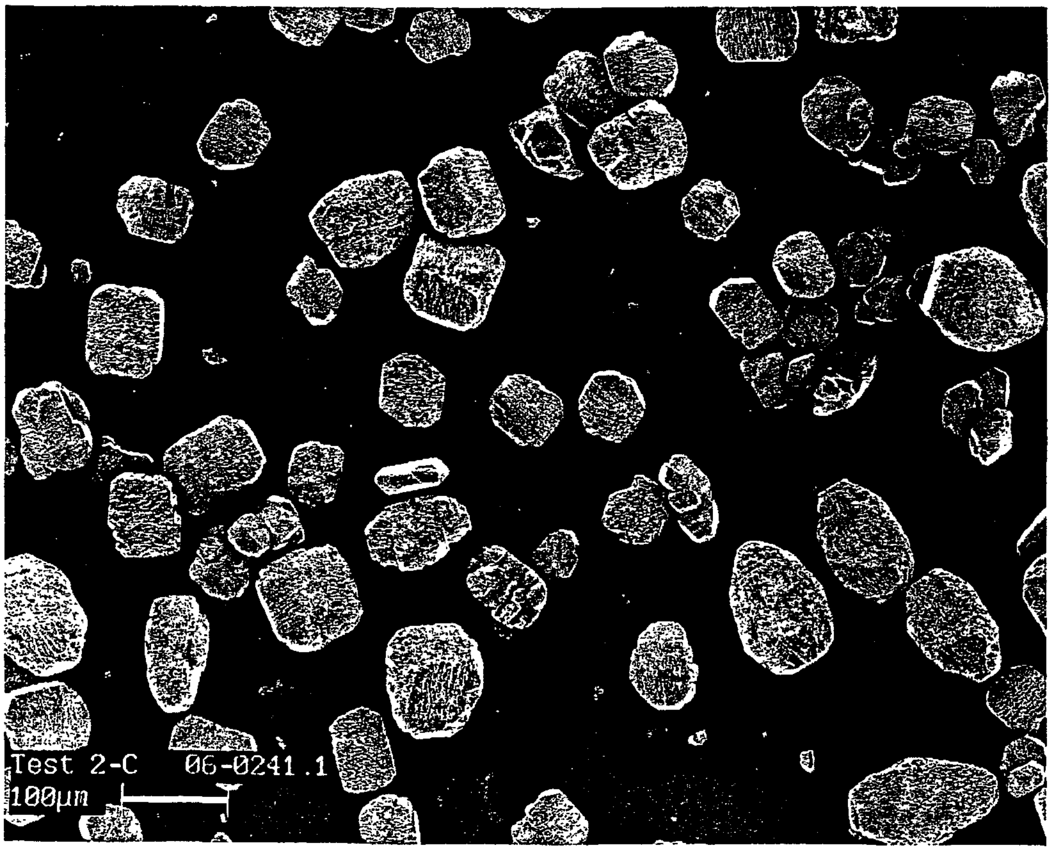
The results of these hydroseparator tests illustrate how important it is to achieve a high oxidation rate in the scrubbers. Not only are the results much better for the coarser composite, but the amount of solids that must be recycled is significantly improved. In the case of the finer composite, about 47% of the solids ended up in the overflow and would have to be recycled. The coarser composite resulted in only 24% of the solids in the overflow for recycle.

Filtration results of the two coarse solids were also significantly different. The finer composite produced an underflow with a full-scale filtration rate of 99.8 lb/hr/ft2 and a filter cake containing 87.8% solids. The coarser composite produced an underflow with a full-scale filtration rate of 388 lb/hr/ft2 and a cake solids concentration of 93.9% solids. The implications on the size of the subsequent dewatering equipment and hours of operation required to dewater the gypsum are significant.

SEMs of the solids in the overflow and underflow from hydroseparator test 2 (the coarser composite) are shown in Figures 9 and 10. The fines contain many fine gypsum solids as well as calcium sulfite, while the coarse solids are essentially just the coarse gypsum solids.

FIGURES 9 AND 10 – HYDROSEPARATOR SAMPLES
SEMS OF FINES (top) IN OVERFLOW AND COARSE IN UNDERFLOW





APPLICATION OF RESULTS TO FULL-SCALE DESIGN

The testing results will now be discussed and applied to the options for improving the dewatering system design and reliability for future operations. The option packages presented earlier will be reviewed with the results of the lab and full-scale evaluations along with experience from other flue gas desulfurization systems.

DESIGN CRITERIA

The design basis for the full-scale dewatering system is as follows based on laboratory results and operating history of the boiler and scrubber units:

800	t/hr coal firing rate for two generating units combined
1.0	Percent maximum sulfur concentration in the coal
0.6	Percent average sulfur concentration in the coal
0.45	Percent minimum sulfur concentration in the coal
0.95	Percent removal of sulfur dioxide from the flue gas
365	tons/day SO2 removal at maximum sulfur coal (combined Units)
40.9	tons/hr gypsum produced at maximum sulfur, 100% oxidation
24.5	tons/hr gypsum produced at average sulfur, 100% oxidation
18.4	tons/hr gypsum produced at minimum sulfur, 1005 oxidation

<u>Hydroseparator Sizing Basis</u>

35.0	ft. diameter hydroseparator for max. sulfur coal & 30-35 micron cut
45-48	wt.% solids in hydroseparator underflow
0.8-1.8	wt.% solid in hydroseparator overflow

<u>Horizontal Vacuum Filter Design Basis – Gypsum Slurry Dewatering</u>

200	lb/hr/ft2 filtration rate for sludge with over 95% gypsum purity
409	sq.ft. filter for maximum sulfur coal, 100% load, 24 hr/day operation
245	sq.ft. filter for average sulfur coal, 100% load, 24-hr/day operation
678	sq.ft. existing drum filters – 2 operational, 1 out of commission

<u>Existing Drum Filters</u>

678	sq.ft. per filter -12-ft. diameter by 18-ft. filters – 3 filters installed
62	lb/hr/ft2 original design filtration rate
32	lb/hr/ft2 measured filtration rate without polymer, 67.5% oxidation
59	lb/hr/ft2 filtration rate with polymer, 67.5% oxidation
20	t/hr filtration rate per filter with polymer at 67.5% oxidation
30	t/hr filtration rate per filter with 83% oxidation (fines removed in thickener overflow)

<u>Thickener Design Basis – Scrubber blowdown</u>

65	ft. diameter existing thickeners – 3 installed
1.5	ft2/t/d sizing basis for 48% underflow with 0.004 lb/t polymer
5	ft2/t/d sizing basis for 40% underflow without polymer

43	ft. diameter thickener required with polymer at maximum sulfur
79	ft. diameter thickener required without polymer, maximum sulfur
45	wt.% solids at 1.364 s.g. design underflow concentration
266	gpm underflow with maximum sulfur coal

Thickener Design Basis – Hydroseparator overflow

3000	gpm hydroseparator overflow to thickener
1.5	gpm/ft2 design basis for thickener
50	ft. diameter thickener required to handle hydroseparator overflow
127	t/day of fines in hydroseparator overflow to thickener
30	wt.% solids in thickener underflow to recycle to limestone slurry tank
56	gpm thickener underflow to recycle

Based on the above design criteria, the option packages for improved dewatering will be discussed for comparison of performance and economics.

Option Package I has the goal of producing saleable gypsum and installing dewatering equipment consistent with typical dewatering for wallboard quality gypsum. Each of the steps in achieving this goal will be discussed here:

Step 1 - To improve oxidation in scrubbers to meet wallboard quality at 95% gypsum or more in the scrubber bleed slurry will require one or more of the following steps:

A. Lower the pH of operation of the scrubbers to 5.5 to 5.8 to allow calcium sulfite to dissolve, oxidize and precipitate as gypsum.

B. Improve the oxidizer and reaction tank design to eliminate taking the bleed slurry from the top of the reaction tank were the finer calcium sulfite particles accumulate. A bleed system design that connects the overflow to the bottom of the reaction tank is one solution so that the level in the tank is maintained, but the slurry comes from the bottom of the tank.

C. Improve the air sparger system to provide additional air and better oxygen transfer.

Step 2 – As a result of step 1, the SO2 removal efficiency of the scrubbers will drop unless a buffer such as sodium formate is added to the recycle slurry. Sodium formate has been shown to be effective at the plant, but its cost has been considered prohibitive, and it has been used only on an intermittent basis when no other tool has been available to meet SO2 compliance. For the oxidation rate to be consistently high at the lower scrubbing pH required, sodium formate will most likely have to be added at a continuous rate, which will require installation of a permanent storage and delivery system.

A. Install a 16,000 gallon tank (7-day storage) with a shoot and bag-spike system and metering pump to produce and deliver 40% sodium formate solution and meter the solution to the limestone slurry tank. Order semi-bulk bags of about

2000 lbs each. Each day an operator loads 4 to 5 bulk bags in tank. Tank is temperature controlled at 100 F by direct steam sparger. Tank level is controlled by water addition. Tank concentration ranges from 40% after bags loaded to 34% just before bags loaded.

B. Pump continuously at 0.5 to 1.5 gpm of sodium formate to the limestone slurry tank to provide liquid-phase alkalinity for improved scrubber performance at the lower pH of operation.

Step 3 - The existing thickeners are not ideally suited for gypsum handling, but can be made to work if the underflow is continuously filtered so that the thickeners can be operated with little or no torque on the drive and with 45 to 55 wt.% solids being delivered continuously to the filter feed tank. Based on the settling tests, one thickener will handle the flow rate of scrubber bleed from both Units as long as the vacuum filters operate continuously.

Step 4 – Install new horizontal belt filter to dewater gypsum slurry to produce a filter cake containing 85 to 90 wt.% solids as a byproduct. The new filter will have at least 409 square feet of active filtration area. One of the existing vacuum filters will be kept as a spare for emergency operation when maintenance needs to be performed on the new horizontal belt filter.

Step 5 – Deliver gypsum filter cake to a new byproduct stack, and load trucks with a front-end loader to take gypsum to end user.

Step 6 – Secure a contract for sale of gypsum

Step 7 – Out-of-spec gypsum will be handled with existing conveying system to landfill and/or blended in with in-spec material.

Option Package IA – Is the same as Option Package I, but instead of improving the scrubbing operation to provide for complete oxidation of the gypsum an external oxidizer will be installed to complete the oxidation of the scrubber bleed slurry to 95% minimum oxidation.

Step 1 – Install a new external oxidizer near the scrubbers to receive approximately 100 gpm of scrubber bleed slurry from each Unit and oxidize the approximately 30% of the solids that are not already oxidized to gypsum. This oxidizer will be approximately 16-ft diameter by 40 feet tall, and will use excess capacity of the existing air compressors to supply approximately 3,400 scfm of air to this new oxidizer.

Step 2 - The existing thickeners are not ideally suited for gypsum handling, but can be made to work if the underflow is continuously filtered so that the thickeners can be operated with little or no torque on the drive and with 45 to 55 wt.% solids being delivered continuously to the filter feed tank. Based on the settling tests, two thickeners will be required, one to provide thickened underflow to recycle to the new oxidizer for density control and the other to feed the new filter to produce byproduct gypsum.

Step 3 – Install sulfuric acid storage and delivery to control the pH in the new oxidizer at about 5 – 5.5 for efficient oxidation. Sulfuric acid usage rate is expected to be about 1400 lb/hr of 80% sulfuric acid or about 1.6 gpm. A one-week supply of onsite storage will require a 17,000 gallon sulfuric acid storage tank.

Step 4 – Install two new horizontal belt filters to dewater gypsum slurry to produce a filter cake containing 85 to 94 wt.% solids as a byproduct. The new filters will have about 240 square feet each of active filtration area. Each filter will handle the full load from both Units with average coal sulfur. Both filters will operate to handle maximum sulfur coal. One of the existing vacuum filters will be kept as a spare for emergency operation when maintenance needs to be performed on the new horizontal belt filters.

Step 5 – Install a new conveyor to deliver gypsum filter cake to a new byproduct stack, and load trucks with a front-end loader to take gypsum to end user.

Step 6 – Secure a contract for sale of gypsum

Step 7 – Out-of-spec gypsum will be handled with existing conveying system to landfill and/or blended in with in-spec material.

Option Package IB – Is the same as Option Package I, but instead of adding new vacuum filters, the existing drum filters are reconditioned. Drum filters are not the ideal filters for gypsum for several reasons, including:

1. The coarse gypsum tends to settle in the vats.
2. The fines concentrate near the surface of the slurry in the vat, and tend to coat the filter cloth and the surface of the filter cake, thereby restricting air flow and lowering filtration rate.
3. The major portion of the filter cycle to produce byproduct gypsum is the dry cycle, which follows a cake wash cycle. A maximum of about 25% of the drum surface is available for cake drying, but about 80% of the cycle time required is for cake drying. Therefore, the filtration surface is not efficiently used, which reduces filtration rates significantly.
4. The fines in the gypsum tend to blind the filter cloth, and the cloth is not able to be efficiently washed to eliminate this blinding.

However, drum filters have been made to work in gypsum applications. Doing so requires additional maintenance time to clean and replace cloths and to clean the filter vats frequently to avoid buildup of coarse solids. Operators must also be trained in how to start-up the filters without blinding the cloths with dilute slurry at the beginning of the filter cycle. The filter cake usually has a little more moisture content than horizontal belt filters, so the end user of the gypsum must be satisfied with this higher moisture content.

Option Package II – Allow oxidation rate in scrubbers to continue to swing between about 65 and 95% and improve existing dewatering equipment or install new equipment to handle the sludge reliably.

Step 1 - Recondition the existing vacuum filters and flyash addition system to be able to operate continuously with no more that 6 – 7 hours or down time between filter runs. The reconditioning includes replacing internal drum piping, adding filter cloth washing nozzles, replacing filter cloths and caulking, replacing plastic grids and rubber division strips, replacing drive motors, vacuum receivers, vacuum pump and motor, drum valve and trunnions on all three filters.

Step 2 – Improve the flyash addition system to eliminate dusting from the operation.

Step 3 - Continue to maintain the filter cloth and all equipment associated with the vacuum filters and polymer feed system.

Step 4 – Operate one vacuum filter continuously and bring on another as needed to keep up with the production rate of solids so that thickener underflow recycle is not required.

Step 5 – Monitor the polymer feed system to both the thickener and the vacuum filters so that the thickeners always produce a clear overflow and the filtration rate on the vacuum filters keeps up with sludge production rates.

Option Package III – Improve scrubber oxidation process to consistently provide a minimum average of about 80% oxidation. Convert the filter feed tank to a hydroseparator and recycle calcium sulfite and fine gypsum back to the scrubbers. Produce byproduct quality gypsum for landfill or for sale.

Step 1 - Improve the consistency of operating conditions in the scrubbers to maintain a maximum scrubber pH of about 5.8 and a suspended solids concentration of 15 wt.% minimum.

Step 2 – Improve the oxidation air spargers for improved contact with air by eliminating the duckbill diffusers.

Step 3 – Improve the overflow design from the reaction tanks to take overflow from the bottom of the reaction tanks.

Step 4 – Convert the existing filter feed tank to a hydroseparator and operate the hydroseparator to send approximately 15 to 25% of the finer solids in the overflow to one of the existing thickeners. Control the hydroseparator underflow at 45 to 50 wt.% solids and continuously feed a new horizontal belt filter to produce gypsum at about 85 to 90 wt.% solids.

Step 5 – Install piping to continuously pump thickened fines from an existing thickener to the limestone slurry tank at about 30 wt.% solids and about 25 to 60 gpm.

Step 6 – Install new horizontal belt filter(s) to dewater the hydroseparator underflow to about 85 to 90 wt.% solids.

Step 7 – Install new conveyor to take the byproduct gypsum to a new gypsum stack, where a front-end loader will load trucks to the end user.

Option Package IIIA is the same as Option Package III, except that the existing vacuum filters are reconditioned instead of replaced with horizontal belt filters. The same comments as for Option Package IB apply to the use of drum filters for gypsum filtration.

Option Package IV – Install a sodium formate system for oxidation rate control as in Option Package I; install a hydroseparator for thickening and fines recycle as in Option package III by converting the existing filter feed tank; and install new horizontal belt filters to meet gypsum byproduct specifications. This option can be completed in one project or in phases as follows:

Phase I – Consists of the following modifications and evaluations:

1. Install the sodium formate storage and delivery system to give operators control of SO2 scrubbing independent of scrubbing pH
2. Convert the existing filter feed tank to a hydroseparator.
3. Once these equipment changes are made, evaluate the dosage and frequency of use of sodium formate along with the projected reagent costs for annual operation to give complete oxidation of the sludge.
4. Evaluate the recycle of hydroseparator overflow containing calcium sulfite to the scrubbers through the limestone addition or return water addition piping.
5. Evaluate oxidation rates and sludge dewatering characteristics as a function of overflow recycle rates.
6. Evaluate the mixing of flyash with hydroseparator overflow for disposal of the fines from the scrubbing process. Finally, document the purity and dewatering characteristics of the gypsum produced.

Phase II – After negotiation of a contract for sale of the byproduct gypsum, complete the installation of horizontal belt filters for dewatering of the gypsum byproduct to meet specifications.

Phase III – Integrate the dewatering operations with Unit 3 gypsum dewatering, which may include additional filters, piping and gypsum conveying and storage.

COST ESTIMATES AND DISCUSSION OF BENEFITS AND RISKS

Cost estimates were developed for each of the Option Packages based on a combination of input data, including budget quotations from equipment vendors, rules of thumb from previous projects and experience of plant engineers. Since the estimates do not include detailed engineering, it is expected that the final project costs could be plus or minus 50% of the estimated costs. The main cost differences would involve changes in scope, materials of construction and inclusion of design details not considered in this study.

Details of the cost estimates are found in the Appendix. Table III is a summary of the capital and operating costs for the option packages:

TABLE III
SUMMARY OF COST ESTIMATES

Option	Description	Capital, $	Operating Cost Change, $/yr
I	Gypsum sale, Sodium Formate, New Filters	$3,678,000	-$755,000
IA	Gypsum sale, External oxidizer, New Filters	$4,526,000	-$955,000
IB	Gypsum sale, Sodium Formate, Recondition Filters	$2,278,000	-$755,000
II	Base case - improve existing equipment and operations	$1,711,000	-$820,000
III	Gypsum sale, Optimize Oxid., Hydroseparator, New Filters	$3,980,000	-$1,455,000
IIIA	Gypsum sale, Optimize Oxid., Hydrosep., Recond. Filters	$2,580,000	-$1,455,000
IV	Gypsum sale, Formate, Hydroseparator, New Filters	$3,930,000	-$755,000

(Cost estimates include capital cost, 15% engineering cost and 25% contingency)

<u>Discussion of Benefits and Risks</u>

<u>Option Package I – Gypsum byproduct using sodium formate and with new horizontal belt filters</u>

This option package makes several improvements over existing operations, including:

1. The sludge becomes fully oxidized through some improvements in the reaction tank and air sparger and by lowering the pH of operation of the scrubbers so that the calcium sulfite can dissolve more rapidly, oxidize and reprecipitate and gypsum.

2. The SO2 emissions control is separated from the oxidation efficiency by using sodium formate buffer that is continuously added to ensure that the lower scrubber operating pH does not reduce scrubbing efficiency.

3. The fully oxidized sludge is easier to filter, gives more consistent dewatering operations and provides the opportunity to sale gypsum as a byproduct.

4. Mixing of filter cake with flyash is no longer required.

5. The existing drum filters are replaced with new horizontal belt filters that are well suited for gypsum dewatering to produce a dry filter cake containing 85 to 94 wt.% solids.

The disadvantages and risks of this modification are considered small, but include the following:

1. Gypsum is usually thickened by hydroclones, but the existing thickeners will be used to save in capital costs. This means that the thickeners will have to be operated with a minimum of sludge inventory and without recycle of the underflow back through the thickener system.

2. The sludge storage capacity of the combined thickener and filter feed tank is only a few hours, nominally 6 to 7 when 1% sulfur coal is being burned. This will require at least one filter to operate continuously, with the other as a spare or as needed to keep up with capacity as the percent sulfur in the coal increases.

3. Sodium formate cost is estimated at $700,000 per year based on a predicted usage rate. This rate has not been proved through on-site testing and could be higher or lower than the estimate.

4. There is minimal risk in not achieving the minimum requirement of 95% gypsum in the solids. However, there is a possibility that the existing air sparger system combined with the lower pH of operation will still not increase the oxidation rate from the current level of 65 to 75% to over 95%.

<u>Option Package IA – Gypsum byproduct using an external oxidizer and new horizontal belt filters</u>

This option package makes several improvements over existing operations, including:

1. The sludge becomes fully oxidized through some improvements in the reaction tank and air sparger and by lowering the pH of operation of the scrubbers so that the calcium sulfite can dissolve more rapidly, oxidize and reprecipitate and gypsum.

2. The SO2 emissions control is separated from the oxidation efficiency by using a new external oxidizer to complete the oxidation process begun in the scrubbers. The scrubbers can focus on meeting compliance for SO2 removal while achieving the current 65 to 75% average oxidation. The new oxidizer will complete the oxidation process to produce the desired 95% plus oxidation to gypsum. This new oxidizer uses excess air capacity of the existing air compressors.

3. The fully oxidized sludge is easier to filter, gives more consistent dewatering operations and provides the opportunity to sale gypsum as a byproduct.

4. Mixing of filter cake with flyash is no longer required.

5. The existing drum filters are replaced with new horizontal belt filters that are well suited for gypsum dewatering to produce a dry filter cake containing 85 to 94 wt.% solids.

The disadvantages and risks of this modification are considered small, but include the following:

1. The new oxidizer is an extra piece of equipment to operate. It must be controlled at a pH of 5 to 5.5 by adding sulfuric acid. The density of the oxidizer must also be control at around 30 wt.% solids to ensure that the gypsum formed has desired dewatering characteristics. This density control is achieved by recycle of thickener underflow to the new oxidizer. The level in the oxidizer must also be sensed and controlled by adjusting the blowdown rate to the thickener feed tank.

2. Gypsum is usually thickened by hydroclones, but the existing thickeners will be used to save in capital costs. This means that the thickeners will have to be operated with a minimum of sludge inventory and without recycle of the underflow back through the thickener system.

3. The sludge storage capacity of the combined thickener and filter feed tank is only a few hours, nominally 6 to 7 when 1% sulfur coal is being burned. This will require at least one filter to operate continuously, with the other as a spare or as needed to keep up with capacity as the percent sulfur in the coal increases.

4. There is minimal risk in not achieving the minimum requirement of 95% gypsum in the solids. There is also a possibility that the new oxidizer will consume more acid than predicted or not produce sludge with the desired settling and filtration characteristics.

5. The operation of the new oxidizer plus recycling of thickener underflow and the storage and feeding of sulfuric acid all add to maintenance costs.

<u>Option Package IB– Gypsum byproduct using sodium formate and with reconditioning of the exiting drum filters</u>

This option package has the same advantages and disadvantages as Option I, but doesn't have the benefit of new horizontal belt filters. It has the disadvantage that the existing drum filters are not well suited for gypsum dewatering. Consequently, the filters will require more operator attention and more frequent maintenance for cloth changes and vat cleaning. The filter cake will have more variable moisture content as the cloth ages, and the operators will have to pay more close attention to the operation and control of the filters to meet desired performance.

<u>Option Package II – Base case with reconditioning existing filters and maintaining existing scrubber operation with small improvements</u>

This option has the advantage of lower capital costs by making no large changes in the existing equipment in the scrubbers or in dewatering. The filters are brought to like new condition with larger vacuum pumps to assist in sludge dewatering. Continuous operation of the filters reduces poor performance of the thickeners and ensures that the thickener overflow is always clear. Oxidation rates will continue to average about 65 to 80%, polymer will be required for both thickening and filtration, and no byproduct gypsum will be produced for sale. It is assumed that the existing flyash conditioning equipment will be improved to control dust in and around the dewatering building.

<u>Option Package III – Gypsum byproduct by separating the fines from the coarse solids with a new hydroseparator plus installation of new horizontal belt filters for improved dewatering</u>

There are several advantages of this option package, including:

1. The existing scrubber system and operation is maintained with only a few improvements to help in consistency of oxidation.

2. By converting the existing filter feed tank to a hydroseparator, the fine calcium sulfite solids can be removed from the coarser gypsum solids. The filtration characteristics of the thickened sludge improve and the finer calcium sulfite is recycled to complete the oxidation process.

3. Two of the three existing thickeners are kept as spares. The third operates to thicken the finer solids from the hydroseparator, so it has much less demanding operation.

4. There is flexibility to recycle fines for oxidation and crystal growth or purging of the fines to the existing pond system for disposal.

5. The new filters will operate more reliably and will produce byproduct quality with cake solids concentrations as high as 94 wt.% solids.

5. The existing flyash conditioning system is not required for mixing with the filter cake.

6. No additional chemicals (sodium formate or sulfuric acid) are required.

The disadvantages and risks may be summarized as follows:

1. The filters must be operated continuously, because the new hydroseparator will have only a few hours of inventory.

2. There is a strong likelihood that full oxidation of the sludge will not be achieved. Consequently, the existing Wastewater Holding Basin will fill up with fine solids over time, although most likely at a lower rate than the existing operation.

<u>Option Package IIIA – The same as Option Package III except that the existing drum filters are reconditioned rather than replaced</u>

This option package has the same advantages and disadvantages as Option III, but doesn't have the benefit of new horizontal belt filters. It has the disadvantage that the existing drum filters are not well suited for gypsum dewatering. Consequently, the filters will require more operator attention and more frequent maintenance for cloth changes and vat cleaning. The filter cake will have more variable moisture content as the cloth ages, and the operators will have to pay more close attention to the operation and control of the filters to meet desired performance.

<u>Option Package IV – Gypsum byproduct using sodium formate, new hydroseparator and with new horizontal belt filters</u>

This option package makes several improvements over existing operations, including:

1. The sludge becomes fully oxidized through some improvements in the reaction tank and air sparger and by lowering the pH of operation of the scrubbers so that the calcium sulfite can dissolve more rapidly, oxidize and reprecipitate and gypsum.

2. The SO2 emissions control is separated from the oxidation efficiency by using sodium formate buffer that is continuously added to ensure that the lower scrubber operating pH does not reduce scrubbing efficiency.

3. By converting the existing filter feed tank to a hydroseparator, the fine calcium sulfite solids can be removed from the coarser gypsum solids. The filtration characteristics of the thickened sludge improve and the finer calcium sulfite is recycled to complete the oxidation process.

4. Two of the three existing thickeners are kept as spares. The third operates to thicken the finer solids from the hydroseparator, so it has much less demanding operation.

5. There is flexibility to recycle fines for oxidation and crystal growth or purging of the fines to the existing pond system for disposal.

6. The new filters will operate more reliably and will produce byproduct quality with cake solids concentrations as high as 94 wt.% solids.

7. The existing flyash conditioning system is not required for mixing with the filter cake.

The disadvantages and risks may be summarized as follows:

1. The sludge storage capacity of the combined thickener and filter feed tank is only a few hours, nominally 6 to 7 when 1% sulfur coal is being burned. This will require at least one filter to operate continuously, with the other as a spare or as needed to keep up with capacity as the percent sulfur in the coal increases.

2. Sodium formate cost is estimated at $700,000 per year based on a predicted usage rate. This rate has not been proved through on-site testing and could be higher or lower than the estimate.

3. There is minimal risk in not achieving the minimum requirement of 95% gypsum in the solids. However, there is a possibility that the existing air sparger system combined with the lower pH of operation will still not increase the oxidation rate from the current level of 65 to 75% to over 95%.

Note that the disadvantages can be completely eliminated by completing the project in phases as described earlier to eliminate uncertainty in subsequent design and operation.

CONCLUSIONS AND RECOMMENDATIONS

Perhaps the biggest dilemma is how do achieve full oxidation of the FGD solids and SO_2 compliance without these two important goals conflicting with each other as they do with the present scrubber design and operating procedures. The primary conflicting variable is operating pH. A relatively high operating pH range has been established to meet SO2 emissions compliance. When the SO2 emissions begin to climb, the pH is raised in the scrubbers, which lowers the oxidation rate. The lower oxidation rate and lower gypsum content of the sludge cause significant degradation of the dewatering characteristics and eliminate the sludge from consideration for byproduct gypsum. All of the option packages discussed in this report address this problem in a different way with varying projected costs.

The next set of decisions involves the status of the existing dewatering equipment and compatibility of that equipment with gypsum dewatering. Should the filters and thickeners be replaced or reconditioned? They are not the most effective dewatering devices for gypsum and they are not functioning well because of their current physical condition. The thickeners can be replaced with a hydroseparator, and the filters with horizontal belt filters specifically designed for gypsum dewatering. The results will be a much better dewatering system with fewer operating and maintenance problems which is capable of achieving byproduct gypsum specifications, but at a higher capital cost than reconditioning the existing equipment.

Finally the decision that must be made is whether to tackle all of the modifications at once or to adopt a staged program with improvements and expenditures completed stepwise over several years. The improvements are adaptable to a staged approach, which may help to resolve the questions about which options will be best for the long run at the least expensive cost. The staged approach is very easily achieved by applying Option IV. The following are the projected costs for a recommended approach to implementing this option:

<u>Phase One – Cost about $1,410,000 capital with savings of up to $820,000/year in operating costs.</u>

Convert the filter feed tank to a hydroseparator, lower the operating pH as much as possible, and make air sparger and reaction tank modifications to improve oxidation. Install a sodium formate system to provide for efficient sulfur dioxide removal at lower pH. Also recondition at least one thickener for fines thickening with the option of recycling fines to the scrubbers or sending a thickened fines stream to the Wastewater Holding Basin or adding the thickened fines to the slurry going to the vacuum filters. Begin operating the vacuum filters continuously.

These changes improve the oxidation rate, provide a consistent product for filtration, keep the coarse gypsum out of the thickeners and improve the filter cake concentration to 85 – 90 wt.% solids. They also allow for evaluation of the hydroseparator operation and the degree of oxidation improvements possible without expenditure of the larger capital cost associated with an external oxidizer or the higher operating costs of sodium formate. The option of eliminating the flyash conditioning system can also be evaluated.

After making the modifications, the three options for the thickened fines can be evaluated as follows: first, they can be recycled to the scrubbers through the limestone slurry tank, second, they can be added to the gypsum slurry going to the filters and third, they can be mixed with flyash and disposed of in the landfill. Of course, they could also be split between the destinations. Evaluations of these options could be completed prior to beginning the next stage.

Savings in operating costs are possible if the fines can be recycled or blended in with the thickened gypsum for filtration, since the Wastewater holding basin will not have to be dredged. There will be some increased operating labor costs for operating the vacuum filters continuously. These costs and the operation of the drum filters with gypsum can be evaluated.

The alternative to the use of sodium formate is to install an external oxidizer, which has a higher capital cost plus uses sulfuric acid and extensive recycle of thickened gypsum seed crystals. It potentially adds another emission source due to the exhausting of the oxidizing air plus maintenance and operating costs for this separate process step. However, it avoids the higher estimated cost of sodium formate. The use of sodium formate seems to be a more flexible, less troublesome alternative.

The operating benefits and costs of using sodium formate can be evaluated, but not incurred unless necessary. Once the benefits, technical aspects and costs of sodium formate are documented, the process will be completely functional to separate control of SO_2 emissions from producing fully oxidized gypsum.

Note also that once the oxidation step is controlled independently from the SO2 emissions, recycle of sludge from the Wastewater holding basin can also be achieved. The dredged solids can be returned to one of the thickeners and from there recycled to the scrubbers for complete oxidation and conversion to gypsum. This process can increase the amount of gypsum byproduct while cleaning the Wastewater Holding Basin.

Phase 2 – Cost about $2,650,000 capital

Finalize a contract and plan for selling gypsum byproduct. Replace existing drum filters with horizontal belt filters and install a new conveyor to the byproduct gypsum stack. Begin receiving revenues for gypsum byproduct which will offset sodium formate costs and/or repay the cost of capital improvements. This step improves the performance of the filters for minimum moisture content of the filter cake and provides new filters for several decades of improved operating reliability and decreased maintenance of the filtration system. The filtration system ensures the capability of meeting byproduct gypsum specifications.

The staged approach has some advantages in that the results of the first phase can be evaluated, and the second phase can be adjusted as needed. The disadvantage is that the operation remains deficient until both phases are completed. However, more time can be allowed for making the biggest expenditures and to allow for decisions to be made regarding gypsum production and byproduct sale for the future generating Unit 3.

The alternative to the staged project approach, of course, is to choose an option package and move forward with it as soon as it can be planned and budgeted. The favored option for ensuring that all of the performance goals are achieved is Option Package IV.

APPENDICES

Laboratory Results
PSDs
SEMs
Cost Estimate Details

Summary Cost Estimates of Options

Option	Description	Capital, $	Operating Cost Change, $/yr	Benefits/disadvantages Summary*
I	Gypsum sale, Sodium Formate, New Filters	$3,678,275	-$755,040	1. Independent control of oxidation and scrubbing efficiency 2. Byproduct gypsum 3. Improved dewatering with right filters for gypsum 4. Thickeners still required in place of 'typical' hydroclones 5. Flyash mixing with cake no longer required
IA	Gypsum sale, External oxidizer, New Filters	$4,526,400	-$955,040	1. Independent control of oxidation and scrubbing efficiency 2. Byproduct gypsum 3. Improved dewatering with right filters for gypsum 4. More equipment (oxidizer) to operate 5. Requires sulfuric acid 6. Thickeners still required, not usual hydroclones 7. Flyash mixing with cake no longer required
IB	Gypsum sale, Sodium Formate, Recondition Filters	$2,278,438	-$755,040	1. Independent control of oxidation and scrubbing efficiency 2. Byproduct gypsum 3. Wrong filters for gypsum 4. Thickeners still required in place of 'typical' hydroclones 5. Flyash mixing with cake no longer required
II	Base case - improve existing equipment and operations	$1,710,625	-$820,000	1. Relies on what hasn't worked in past to work this time 2. Improve existing equipment to work better 3. No gypsum byproduct 4. Operating improvements required 5. Flyash system must be improved
III	Gypsum sale, Optimize Oxidation, Hydrosepartor, New Filters	$3,980,150	-$1,455,040	1. Relies on recycle to provide complete oxidation - risk 2. Byproduct gypsum 3. Improved dewatering with right filters for gypsum 4. Only one thickener required 5. Doesn't require additional chemicals 6. Minimal oxidation improvements - relies also on operations 7. Option to purge fines to ensure system works 8. Flyash mixing with cake no longer required
IIIA	Gypsum sale, Optimize Oxidation, Hydroseparator, Recondition Filters	$2,580,313	-$1,455,040	1. Relies on recycle to provide complete oxidation - risk 2. Byproduct gypsum 3. Wrong filters for gypsum 4. Only one thickener required 5. Doesn't require additional chemicals 6. Minimal oxidation improvements - relies also on operations 7. Option to purge fines to ensure system works 8. Flyash mxing with cake no longer required
IV	Gypsum sale, Sodium Formate, Hydroseparator, New Filters	$3,929,838	-$755,040	1. Independent control of oxidation and scrubbing efficiency 2. Byproduct gypsum 3. Improved dewatering with right filters for gypsum 4. Only one thickener required 5. Option to purge fines to ensure system works 6. Flyash mixing with cake no longer required 7. Requires formate for some periods of operation

* All options assume more continuous operation of filtration system with no more than about 6 - 7 hours between filter cycles
All gypsum options assume that flyash mixing is no longer required
All options designed for maximum sulfur coal, but average sulfur coal used for gypsum revenues

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Cost Estimates for Dewatering Options - IPSC

Option Package I Produce saleable gypsum through scrubber and dewatering equipment improvements

Improvement	Estimated Capital, $	Operating Cost Change, $/yr	
1. Improve scrubber oxidation rate to minimum average of 95% oxidation			
A. Lower pH in scrubbers to 5.5 - 5.8	$0	$0	
B. Improve reaction tank to take bleed from bottom	$150,000		
C. Improve air sparger system	$120,000		
2. Install Sodium Formate System			
A. 16,000 gallon tank with semi-bulk bag chute	$50,000		
B. Install steam direct heat and controls	$25,000		
C. Install water line, valve and controls	$10,000		
D. Install metering pump to limestone slurry tank	$30,000		
E. Feed sodium formate at 1 gpm (4.3 lb/min dry)		$700,000	$0.31/dry lb. delivered Hercules
3. Operate continuous thickeners without recycle	$0	$0	
4 Repair thickener tanks	$300,000		
5 Install new HB Filters			
A. Two (2) 22.2 m2 filters	$1,265,000		
B. Freight	$18,800		
C. Installation	$520,000		
D Field Service - 20 days	$20,000		
E Continuous filter operation		$180,000	
6 New Conveyor to new gypsum stack	$50,000		
7 Revenue from sale of gypsum		$635,040	588 t/day 3 $/t
8 Savings in pond cleaning costs		$1,000,000	
9 Engineering at 15%	$383,820		
10 Contingency at 25%	$735,655		
Total Costs	$3,678,275	-$755,040	

Cost Estimates for Dewatering Options - IPSC

Option Package IA Same as Option 1 but with external oxidizer

	Estimated Capital, $	Operating Cost Change, $/yr	
1. Install a new External Oxidizer			
A. Install 16-ft dia. by 40-ft high oxidizer plus piping	$400,000	$0	
B. Run air lines from compressors	$150,000		
2. Run lines from thickener underflow back to oxidizer	$125,000		
3 Repair thickener tanks	$300,000		
4 Install sulfuric acid tank and feed system	$300,000	$500,000	$90/ton (budget from Thatcher/Kennecott)
5 Install new HB Filters			
A. Two (2) 22.2 m2 filters	$1,265,000		
B. Freight	$18,800		
C. Installation	$520,000		
D Field Service - 20 days	$20,000		
E Continuous filter operation		$180,000	
6 New Conveyor to new gypsum stack	$50,000		
7 Revenue from sale of gypsum		$635,040	588 t/day 3 $/t
8 Savings in pond cleaning costs		$1,000,000	
9 Engineering at 15%	$472,320		
10 Contingency at 25%	$905,280		
Total Costs	$4,526,400	-$955,040	

Cost Estimates for Dewatering Options - IPSC

Option Package IB Same as option 1 but with reconditioned filters

Improvement	Estimated Capital, $	Operating Cost Change, $/yr	
1. Improve scrubber oxidation rate to minimum average of 95% oxidation			
A. Lower pH in scrubbers to 5.5 - 5.8	$0	$0	
B. Improve reaction tank to take bleed from bottom	$150,000		
C. Improve air sparger system	$120,000		
2. Install Sodium Formate System			
A. 16,000 gallon tank with semi-bulk bag chute	$50,000		
B. Install steam direct heat and controls	$25,000		
C. Install water line, valve and controls	$10,000		
D. Install metering pump to limestone slurry tank	$30,000		
E. Feed sodium formate at 1 gpm (4.3 lb/min dry)		$700,000	$0.31/dry lb. delivered Hercules
3. Operate continuous thickeners without recycle	$0	$0	
4 Repair thickener tanks	$300,000		
5 Recondition Existing Filters	$850,000		
Continuous filter operation		$180,000	
6 New Conveyor to new gypsum stack	$50,000		
7 Revenue from sale of gypsum		$635,040	588 t/day 3 $/t
8 Savings in pond cleaning costs		$1,000,000	
9 Engineering at 15%	$237,750		
10 Contingency at 25%	$455,688		
Total Costs	$2,278,438	-$755,040	

Cost Estimates for Dewatering Options - IPSC

Option Package II Don't touch scrubbers, improve existing dewatering system to handle poorly oxidized sludge

	Estimated Capital, $	Operating Cost Change, $/yr	
1. Recondition existing vacuum filters	$850,000		
2. Improve flyash conditioning system	$0		already being done
3. Continuous Vacuum Filter Operation		$180,000	
4. Eliminate thickener underflow recycle			
5 Repair thickener tanks	$300,000		
6 Improve polymer system for filters and thickeners	$40,000		
7 Savings in pond cleaning costs		$1,000,000	
8 Engineering at 15%	$178,500		
9 Contingency	$342,125		
Total Costs	$1,710,625	-$820,000	

Cost Estimates for Dewatering Options - IPSC

Option Package III Improve scrubber oxidation without significant operating costs, use hydroseparator to improve dewatering

	Estimated Capital, $	Operating Cost Change, $/yr			
1. Improve scrubber operation consistency	$0	$0			
2. Improve air spargers	$120,000	$0			
3 Improve reaction tank to take bleed from bottom	$150,000				
4 Convert filter feed tank to hydroseparator	$400,000	$0			
5 Install thickened fines recycle to LS slurry tank	$125,000				
6 Repair one thickener tank	$100,000				
7 Install new HB Filters					
A. Two (2) 22.2 m2 filters	$1,265,000				
B. Freight	$18,800				
C. Installation	$520,000				
D Field Service - 20 days	$20,000				
E Continuous filter operation		$180,000			
8 New Conveyor to new gypsum stack	$50,000				
9 Revenue from sale of gypsum		$635,040	588 t/day	$3	$/t
10 Savings in pond cleaning costs		$1,000,000			
11 Engineering at 15%	$415,320				
12 Contingency at 25%	$796,030				
Total Costs	$3,980,150	-$1,455,040			

Cost Estimates for Dewatering Options - IPSC

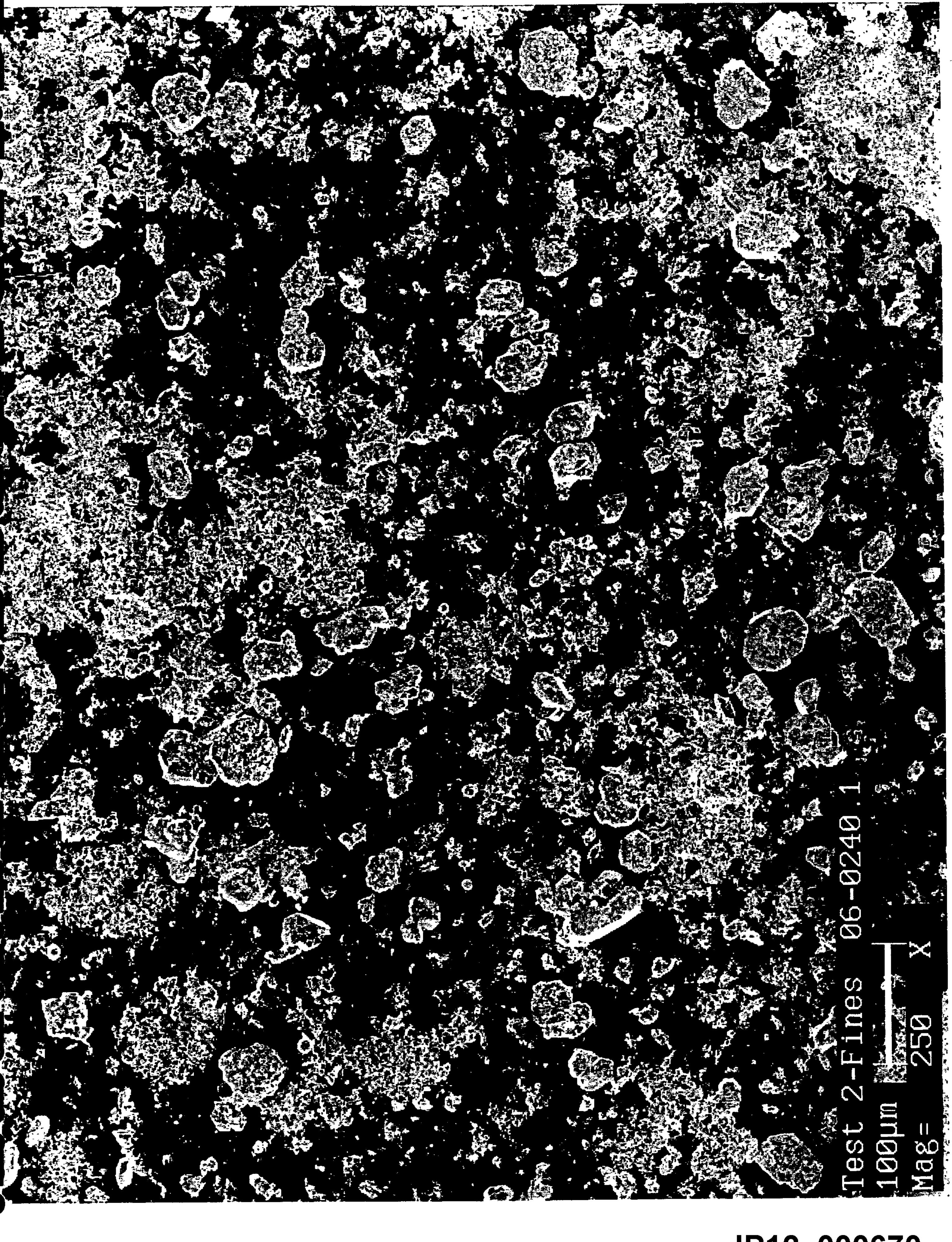
Option Package IIIA Same as option III but stay with existing drum filters

		Estimated Capital, $	Operating Cost Change, $/yr		
	1. Improve scrubber operation consistency	$0	$0		
	2. Improve air spargers	$120,000	$0		
	3 Improve reaction tank to take bleed from bottom	$150,000			
	4 Convert filter feed tank to hydroseparator	$400,000	$0		
	5 Install thickened fines recycle to LS slurry tank	$125,000			
	6 Repair one thickener tank	$100,000			
	7 Recondition existing vacuum filters	$850,000			
	8 New Conveyor to new gypsum stack	$50,000			
	9 Continuous Vacuum Filter Operation		$180,000		
	10 Revenue from sale of gypsum		$635,040	588 t/day	3 $/t
	11 Savings in pond cleaning costs		$1,000,000		
	12 Engineering at 15%	$269,250			
	13 Contingency at 25%	$516,063			
Total Costs		$2,580,313	-$1,455,040		

Cost Estimates for Dewatering Options - IPSC

Option Package IV Improve scrubber oxidation & add sodium formate system, use hydroseparator and add new HBF vacuum filters

	Estimated Capital, $	Operating Cost Change, $/yr	
1. Improve scrubber operation consistency	$0	$0	
2. Improve air spargers	$120,000	$0	
3 Install Sodium Formate System			
A. 16,000 gallon tank with semi-bulk bag chute	$50,000		
B. Install steam direct heat and controls	$25,000		
C. Install water line, valve and controls	$10,000		
D. Install metering pump to limestone slurry tank	$30,000		
E. Feed sodium formate at 1 gpm (4.3 lb/min dry)		$700,000	$0.31/dry lb. delivered Hercu
4 Convert filter feed tank to hydroseparator	$400,000	$0	
5 Install thickened fines recycle to LS slurry tank	$125,000		
6 Repair one thickener tank	$100,000		
7 Install new HB Filters			
A. Two (2) 22.2 m2 filters	$1,265,000		
B. Freight	$18,800		
C. Installation	$520,000		
D Field Service - 20 days	$20,000		
E Continuous filter operation		$180,000	
8 New Conveyor to new gypsum stack	$50,000		
9 Revenue from sale of gypsum		$635,040	588 t/day $3 $/t
10 Savings in pond cleaning costs		$1,000,000	
11 Engineering at 15%	$410,070		
12 Contingency at 25%	$785,968		
Total Costs	$3,929,838	-$755,040	



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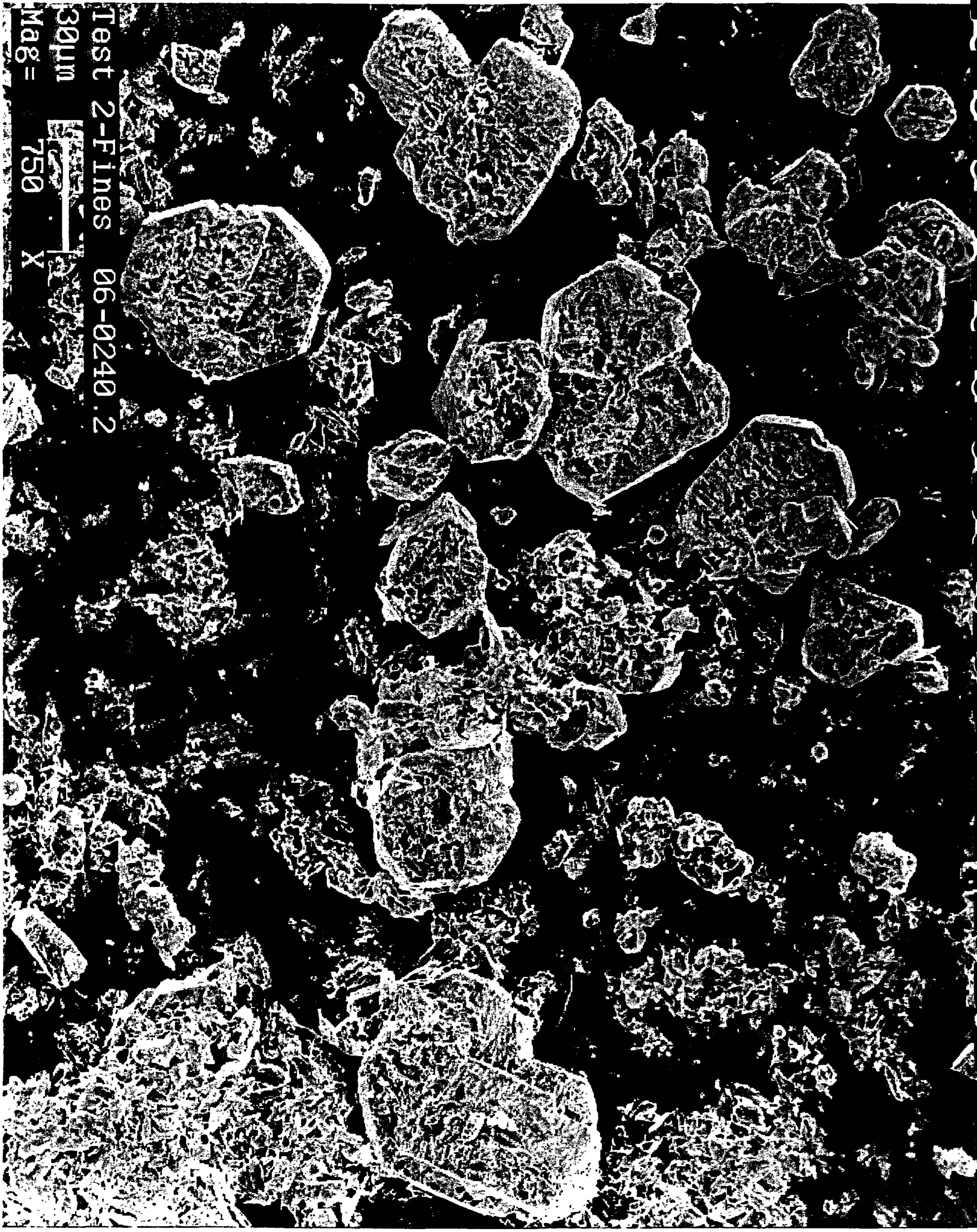
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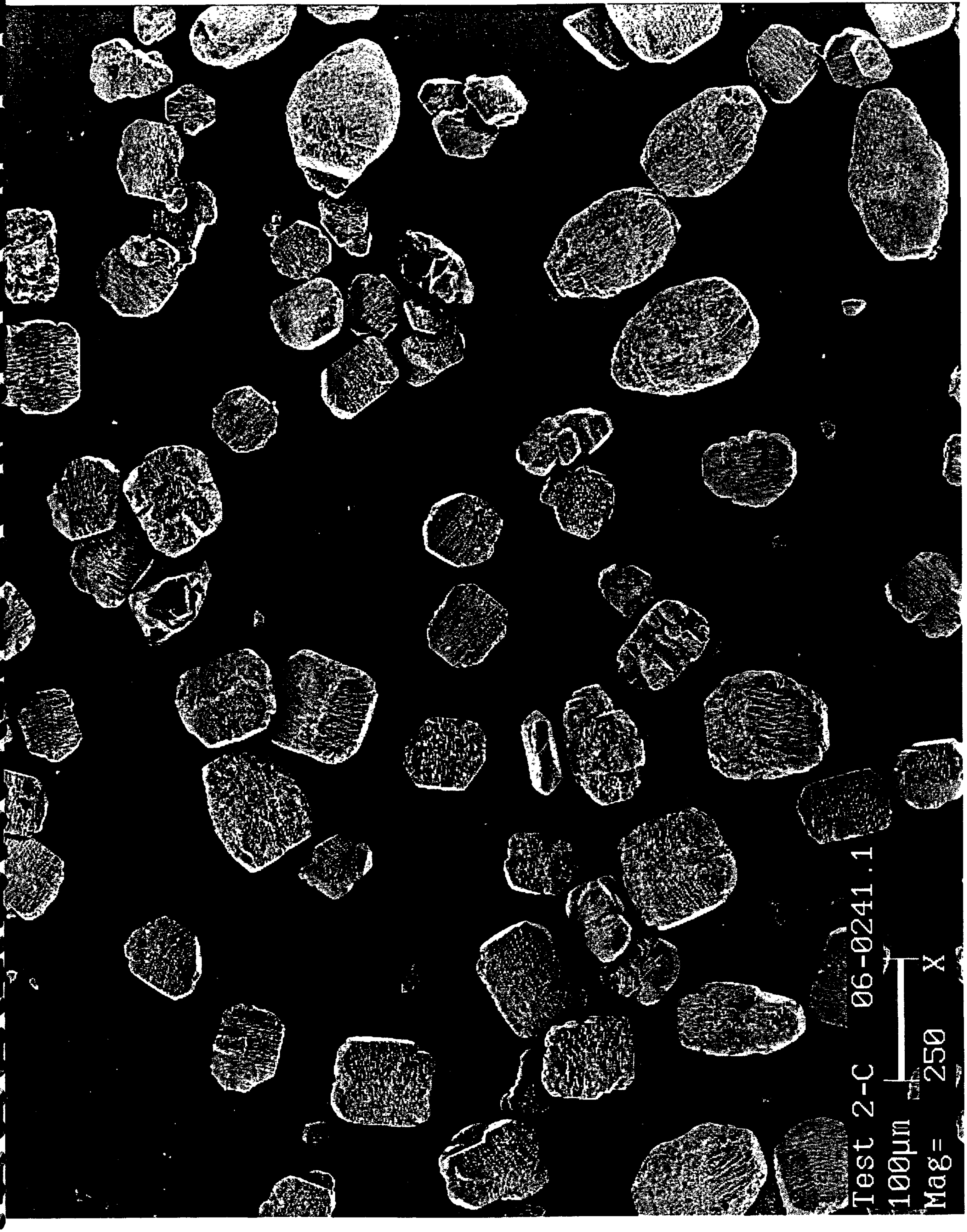
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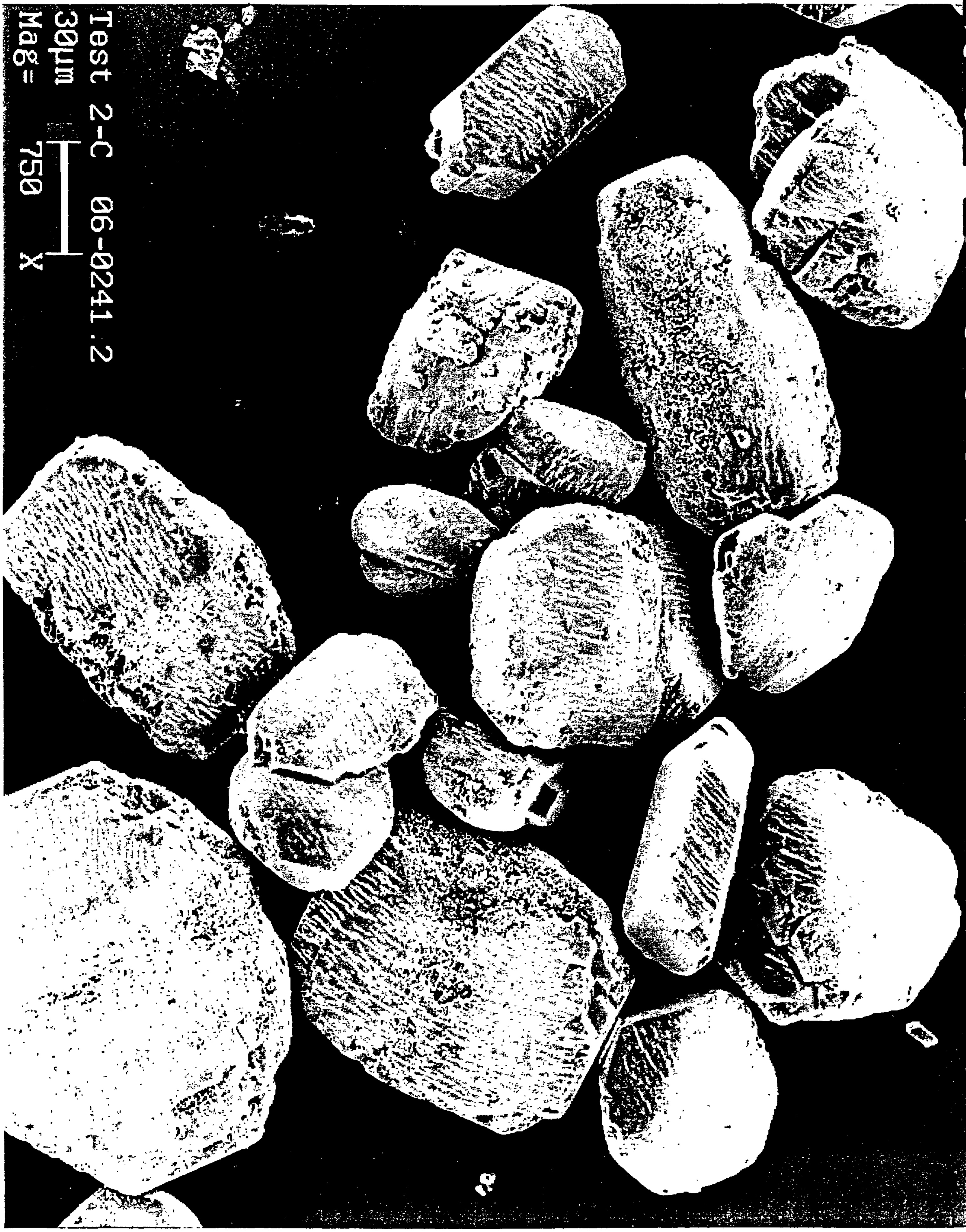
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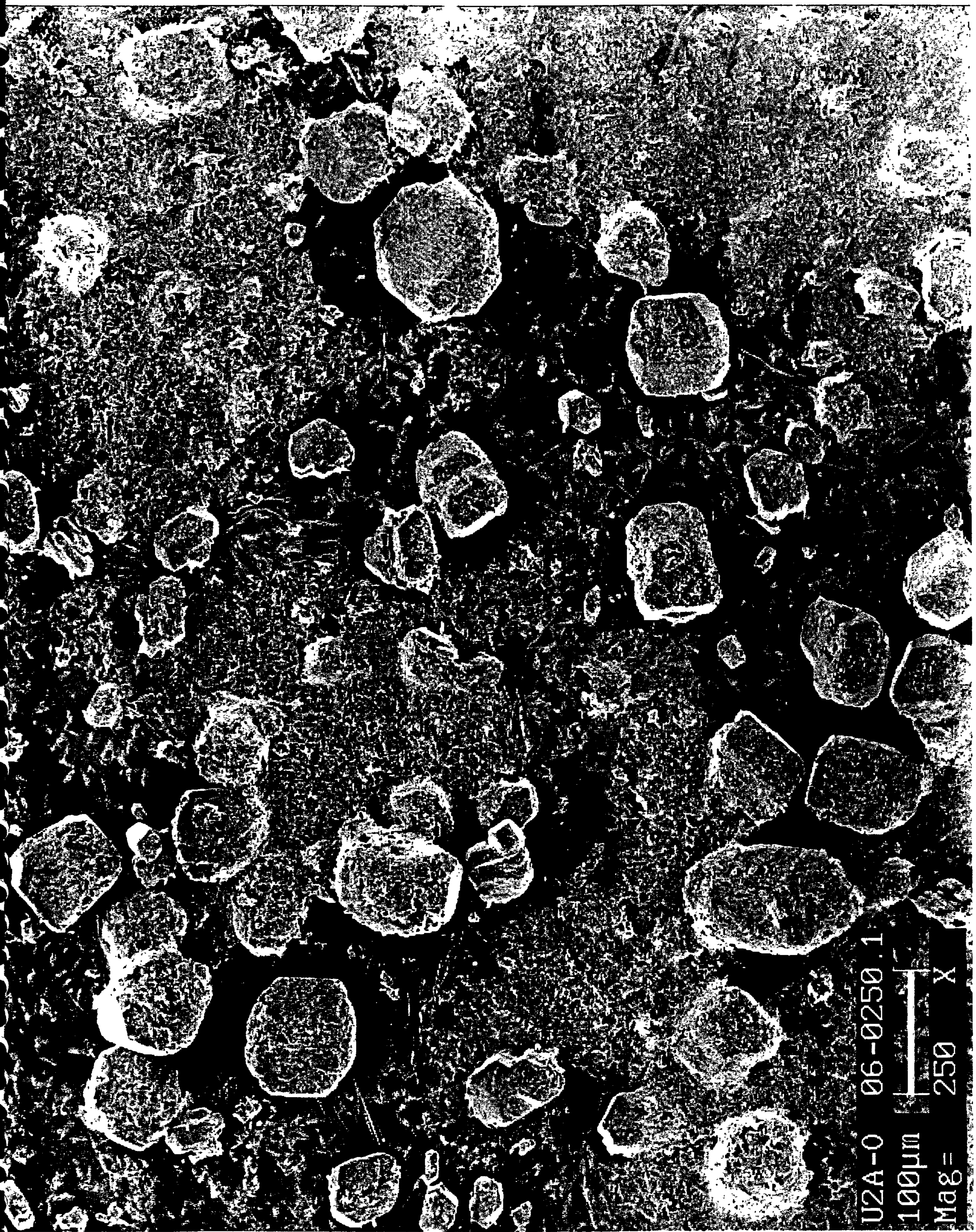
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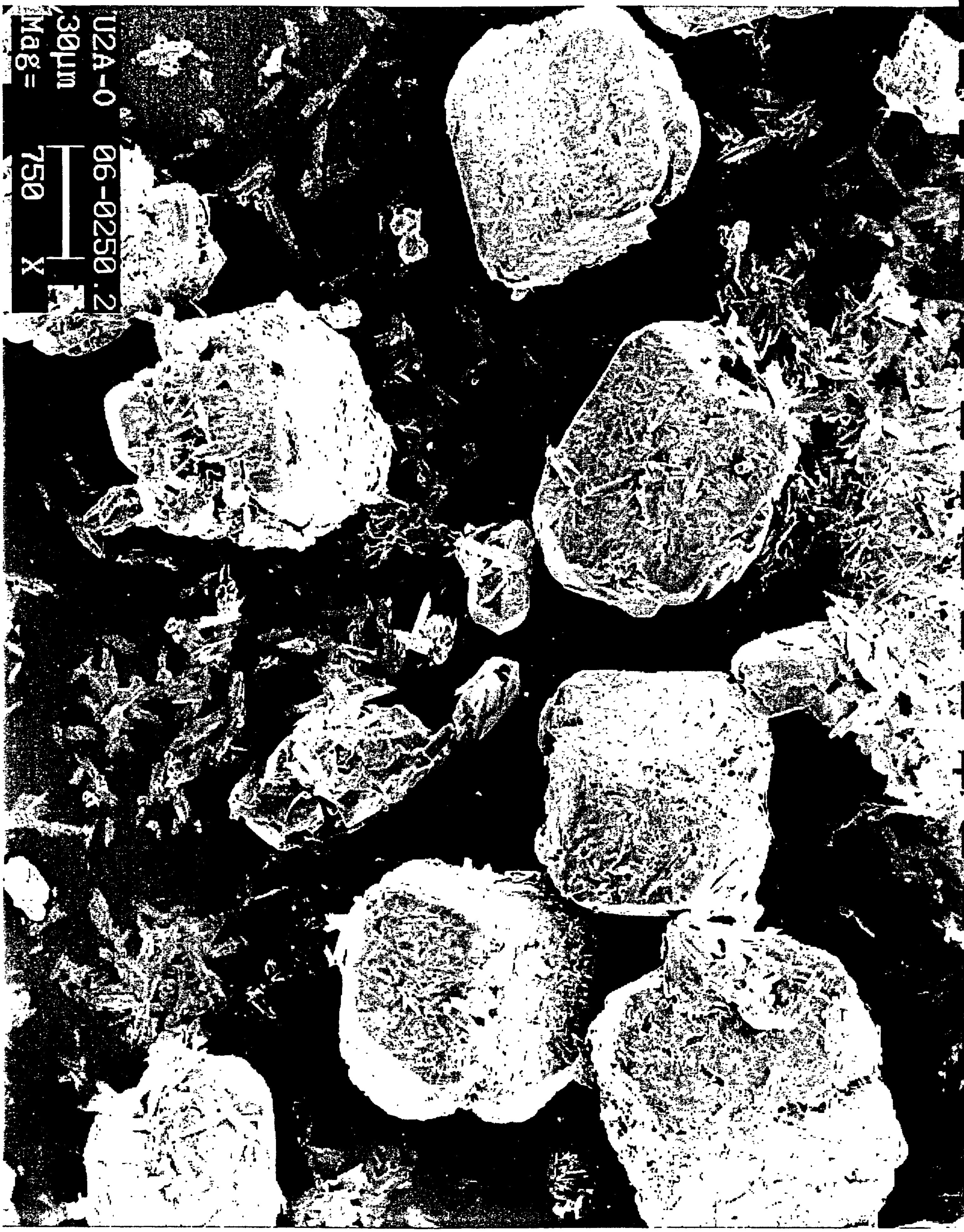
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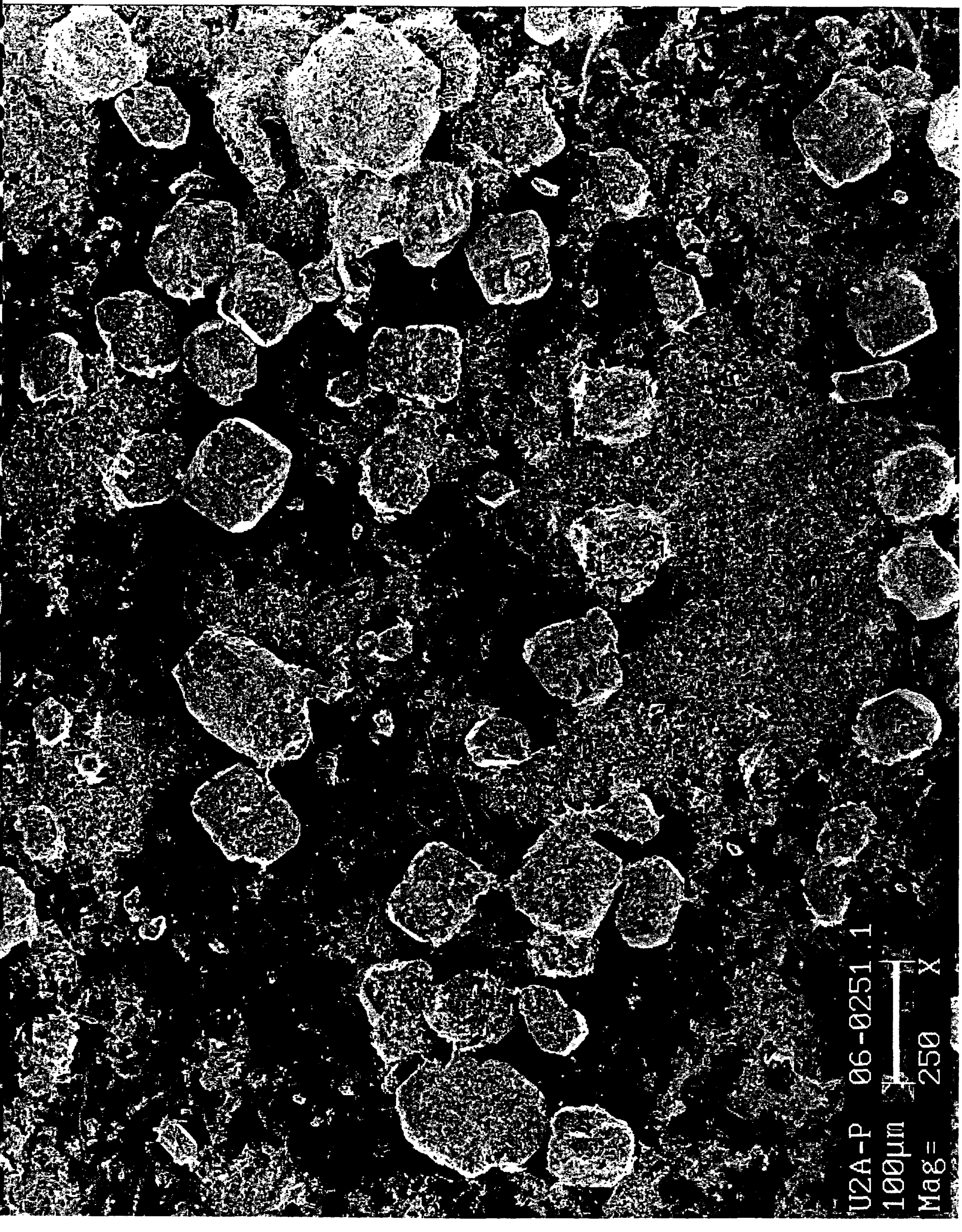
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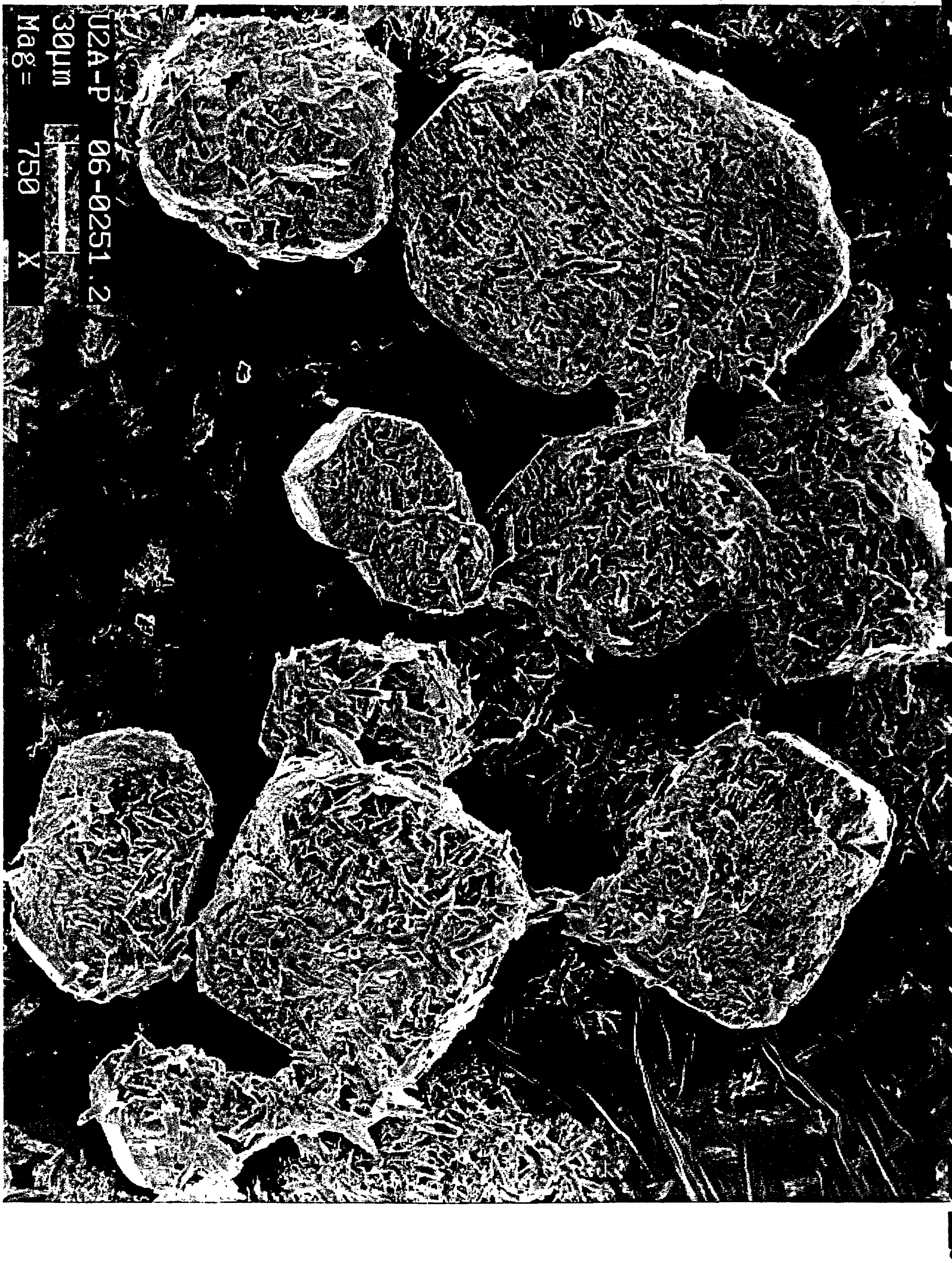
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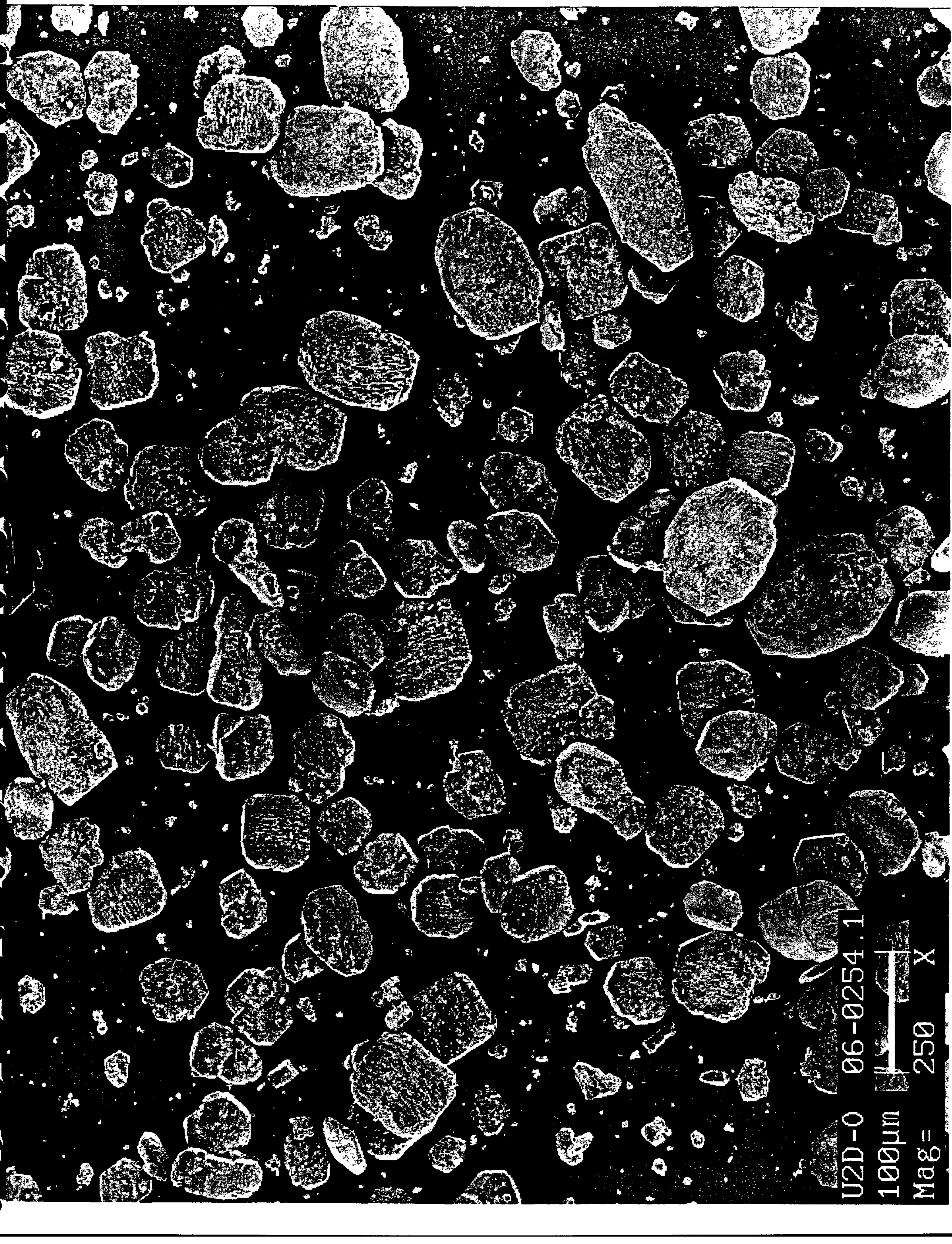
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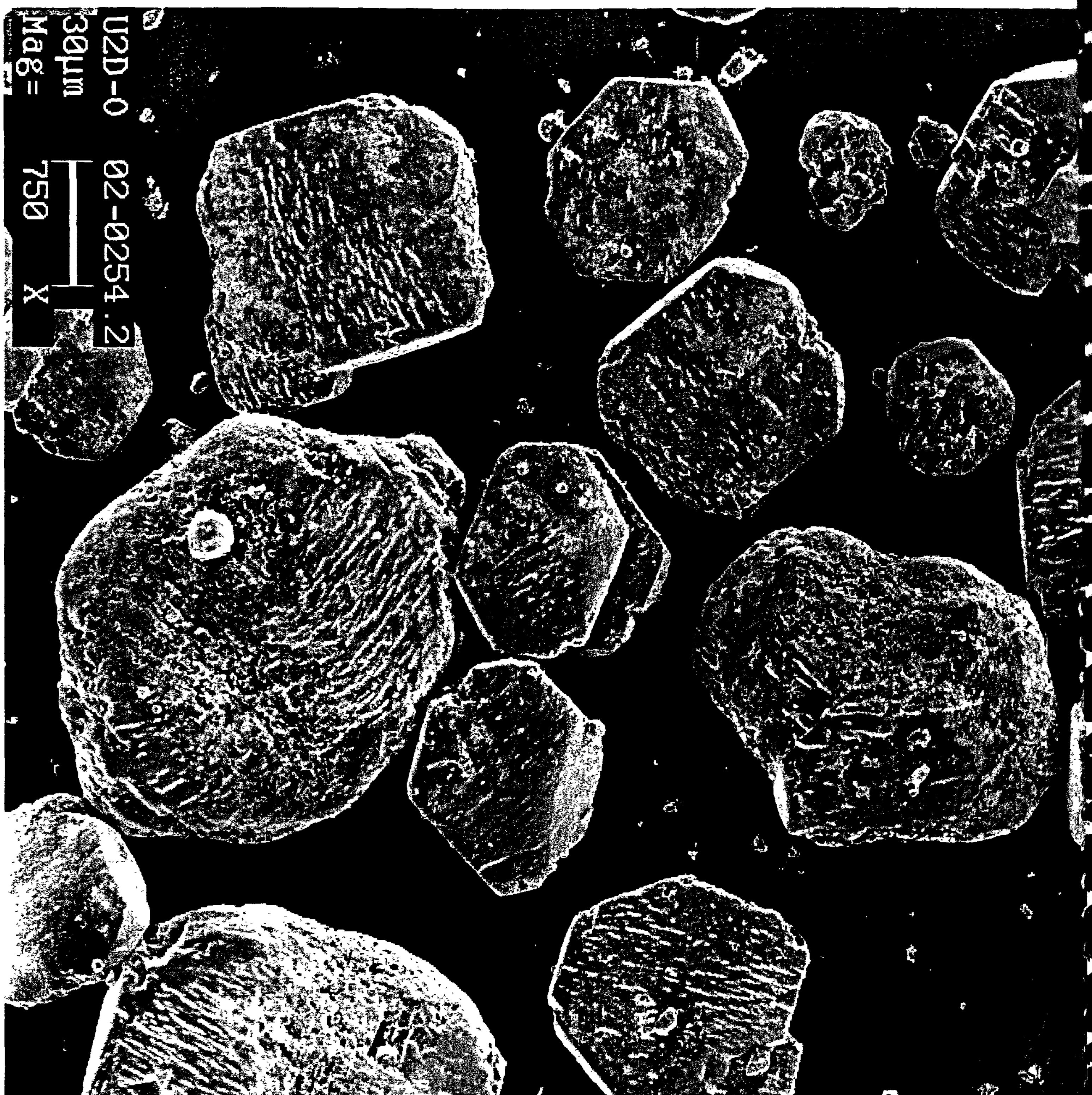
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LECOTRAC - LT100

Ver:7.02

Carmeuse Tech Center	06-0237 Test 1-Feed	Date: 04/17/06 Meas #: 166 Time: 14:16 Pres #: 1

Codan Associates (5242 mgp)
Project: 5004
Test 1-Feed

Attn: J Wilhelm

Summary	Percentiles	
mv = 29.60	10% = 4.333	60% = 26.39
mn = 3.583	20% = 6.094	70% = 41.46
ma = 10.04	30% = 7.804	80% = 53.65
cs = 0.597	40% = 9.988	90% = 70.16
sd = 26.86	50% = 14.08	95% = 87.39

Dia	Vol%	Width
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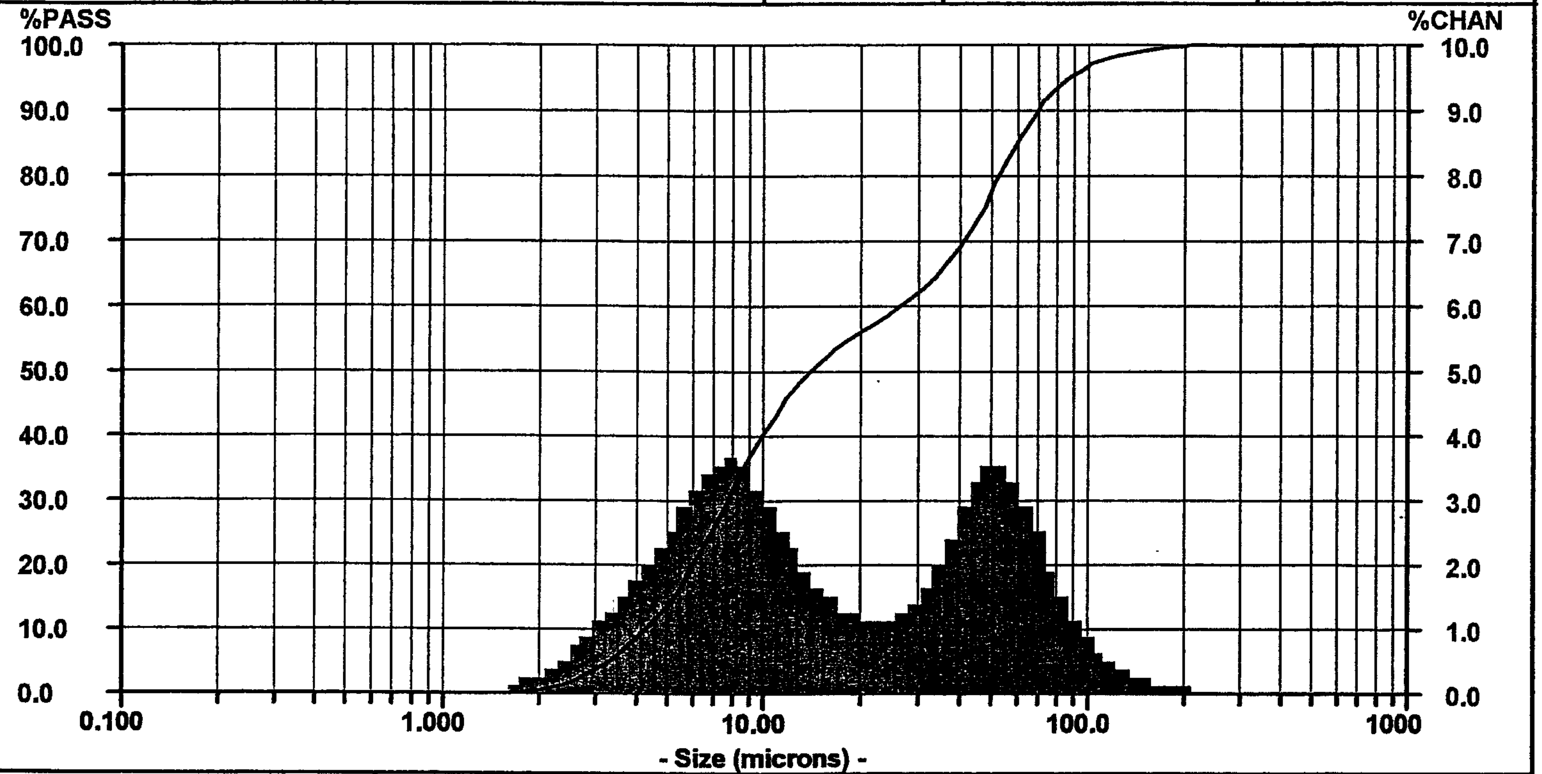
7.573	57%	8.878



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704.0	100.00	0.00	80.70	93.54	2.02	9.250	37.09	3.55	1.060	0.00	0.00
645.6	100.00	0.00	74.00	91.52	2.54	8.482	33.54	3.68	0.972	0.00	0.00
592.0	100.00	0.00	67.86	88.98	3.01	7.778	29.86	3.66	0.892	0.00	0.00
542.9	100.00	0.00	62.23	85.97	3.41	7.133	26.20	3.52	0.818	0.00	0.00
497.8	100.00	0.00	57.06	82.56	3.59	6.541	22.68	3.26	0.750	0.00	0.00
456.5	100.00	0.00	52.33	78.97	3.57	5.998	19.42	2.95	0.688	0.00	0.00
418.6	100.00	0.00	47.98	75.40	3.35	5.500	16.47	2.61	0.630	0.00	0.00
383.9	100.00	0.00	44.00	72.05	2.94	5.044	13.86	2.31	0.578	0.00	0.00
352.0	100.00	0.00	40.35	69.11	2.52	4.625	11.55	2.03	0.530	0.00	0.00
322.8	100.00	0.00	37.00	66.59	2.11	4.241	9.52	1.79	0.486	0.00	0.00
296.0	100.00	0.00	33.93	64.48	1.77	3.889	7.73	1.58	0.446	0.00	0.00
271.4	100.00	0.00	31.11	62.71	1.51	3.566	6.15	1.37	0.409	0.00	0.00
248.9	100.00	0.00	28.53	61.20	1.33	3.270	4.78	1.17	0.375	0.00	0.00
228.2	100.00	0.00	26.16	59.87	1.24	2.999	3.61	0.98	0.344	0.00	0.00
209.3	100.00	0.14	23.99	58.63	1.19	2.750	2.63	0.78	0.315	0.00	0.00
191.9	99.86	0.21	22.00	57.44	1.20	2.522	1.85	0.61	0.289	0.00	0.00
176.0	99.65	0.22	20.17	56.24	1.27	2.312	1.24	0.45	0.265	0.00	0.00
161.4	99.43	0.26	18.50	54.97	1.38	2.121	0.79	0.34	0.243	0.00	0.00
148.0	99.17	0.32	16.96	53.59	1.54	1.945	0.45	0.28	0.223	0.00	0.00
135.7	98.85	0.41	15.56	52.05	1.75	1.783	0.17	0.17	0.204	0.00	0.00
124.5	98.44	0.52	14.27	50.30	2.00	1.635	0.00	0.00	0.187	0.00	0.00
114.1	97.92	0.69	13.08	48.30	2.31	1.499	0.00	0.00	0.172	0.00	0.00
104.7	97.23	0.91	12.00	45.99	2.63	1.375	0.00	0.00	0.158	0.00	0.00
95.96	96.32	1.20	11.00	43.36	2.98	1.261	0.00	0.00	0.145	0.00	0.00
88.00	95.12	1.58	10.09	40.38	3.29	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.2381
Transmission: 0.84
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

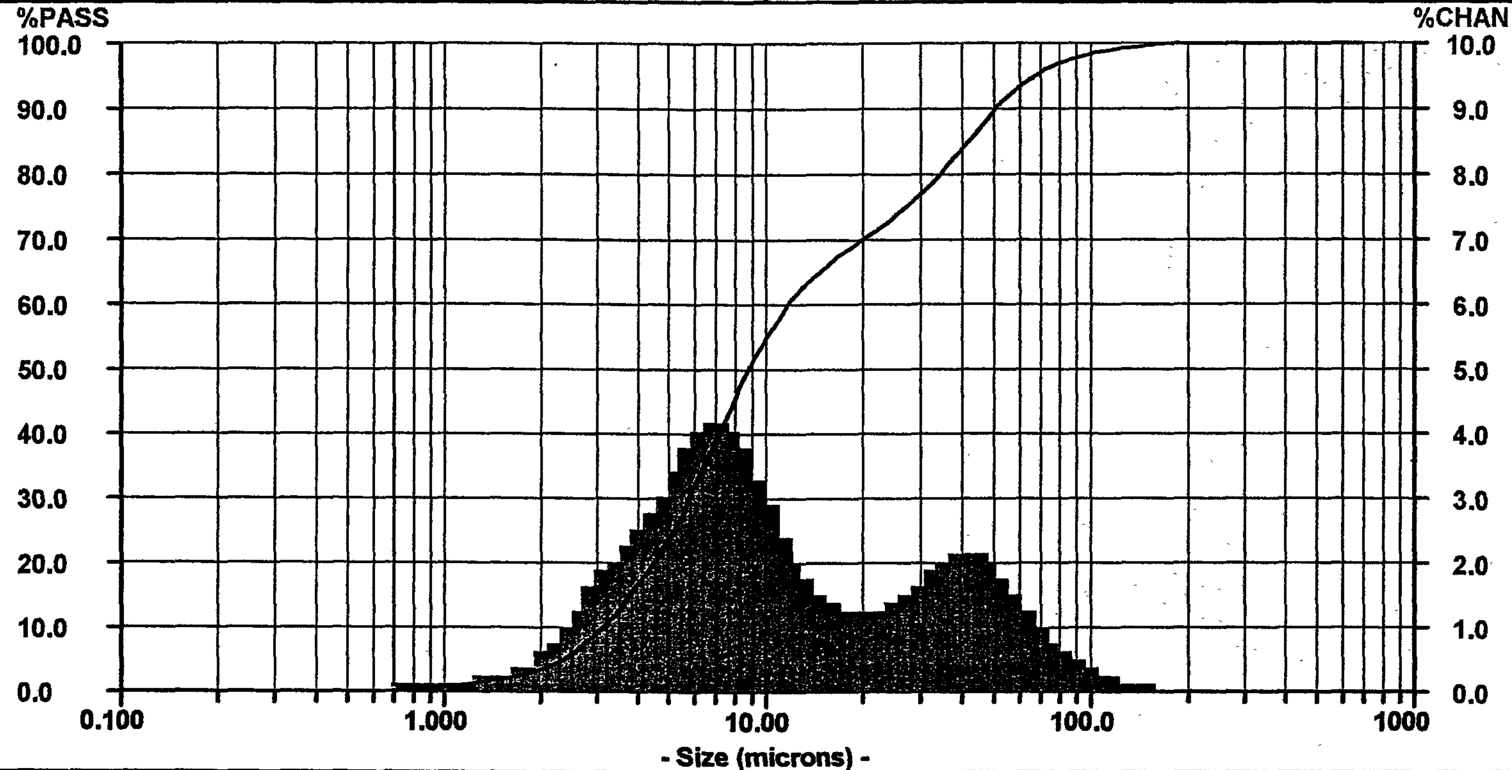
Ver:7.0

Carmeuse Tech Center	06-0238 Test 1-Fines	Date: 04/17/06 Meas #: 180 Time: 16:23 Pres #: 1

Codan Associates (5243 mgp)
Project: 5004
Test 1-Fines

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 19.71	10% = 3.151	60% = 11.80	41.20	31%	41.77
mn = 1.640	20% = 4.529	70% = 19.99	6.444	69%	7.656
ma = 6.635	30% = 5.859	80% = 34.58			
cs = 0.904	40% = 7.217	90% = 51.39			
sd = 18.28	50% = 8.900	95% = 67.19			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	97.04	0.84	9.250	51.66	3.82	1.060	0.98	0.24
645.6	100.00	0.00	74.00	96.20	1.06	8.482	47.84	4.12	0.972	0.74	0.22
592.0	100.00	0.00	67.86	95.14	1.30	7.778	43.72	4.30	0.892	0.52	0.20
542.9	100.00	0.00	62.23	93.84	1.58	7.133	39.42	4.28	0.818	0.32	0.19
497.8	100.00	0.00	57.06	92.26	1.83	6.541	35.14	4.08	0.750	0.13	0.13
456.5	100.00	0.00	52.33	90.43	2.07	5.998	31.06	3.80	0.688	0.00	0.00
418.6	100.00	0.00	47.98	88.36	2.22	5.500	27.26	3.44	0.630	0.00	0.00
383.9	100.00	0.00	44.00	86.14	2.26	5.044	23.82	3.11	0.578	0.00	0.00
352.0	100.00	0.00	40.35	83.88	2.23	4.625	20.71	2.82	0.530	0.00	0.00
322.8	100.00	0.00	37.00	81.65	2.10	4.241	17.89	2.56	0.486	0.00	0.00
296.0	100.00	0.00	33.93	79.55	1.94	3.889	15.33	2.35	0.446	0.00	0.00
271.4	100.00	0.00	31.11	77.61	1.75	3.566	12.98	2.13	0.409	0.00	0.00
248.9	100.00	0.00	28.53	75.86	1.59	3.270	10.85	1.92	0.375	0.00	0.00
228.2	100.00	0.00	26.16	74.27	1.46	2.999	8.93	1.66	0.344	0.00	0.00
209.3	100.00	0.00	23.99	72.81	1.36	2.750	7.27	1.38	0.315	0.00	0.00
191.9	100.00	0.00	22.00	71.45	1.31	2.522	5.89	1.12	0.289	0.00	0.00
176.0	100.00	0.12	20.17	70.14	1.31	2.312	4.77	0.86	0.265	0.00	0.00
161.4	99.88	0.19	18.50	68.83	1.36	2.121	3.91	0.66	0.243	0.00	0.00
148.0	99.69	0.20	16.96	67.47	1.45	1.945	3.25	0.50	0.223	0.00	0.00
135.7	99.49	0.23	15.56	66.02	1.60	1.783	2.75	0.40	0.204	0.00	0.00
124.5	99.26	0.28	14.27	64.42	1.83	1.635	2.35	0.33	0.187	0.00	0.00
114.1	98.98	0.34	13.08	62.59	2.13	1.499	2.02	0.29	0.172	0.00	0.00
104.7	98.64	0.42	12.00	60.46	2.49	1.375	1.73	0.26	0.158	0.00	0.00
95.96	98.22	0.52	11.00	57.97	2.93	1.261	1.47	0.25	0.145	0.00	0.00
88.00	97.70	0.66	10.09	55.04	3.38	1.156	1.22	0.24	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1206
Transmission: 0.89
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

IP12_000681

LECOTRAC - LT100

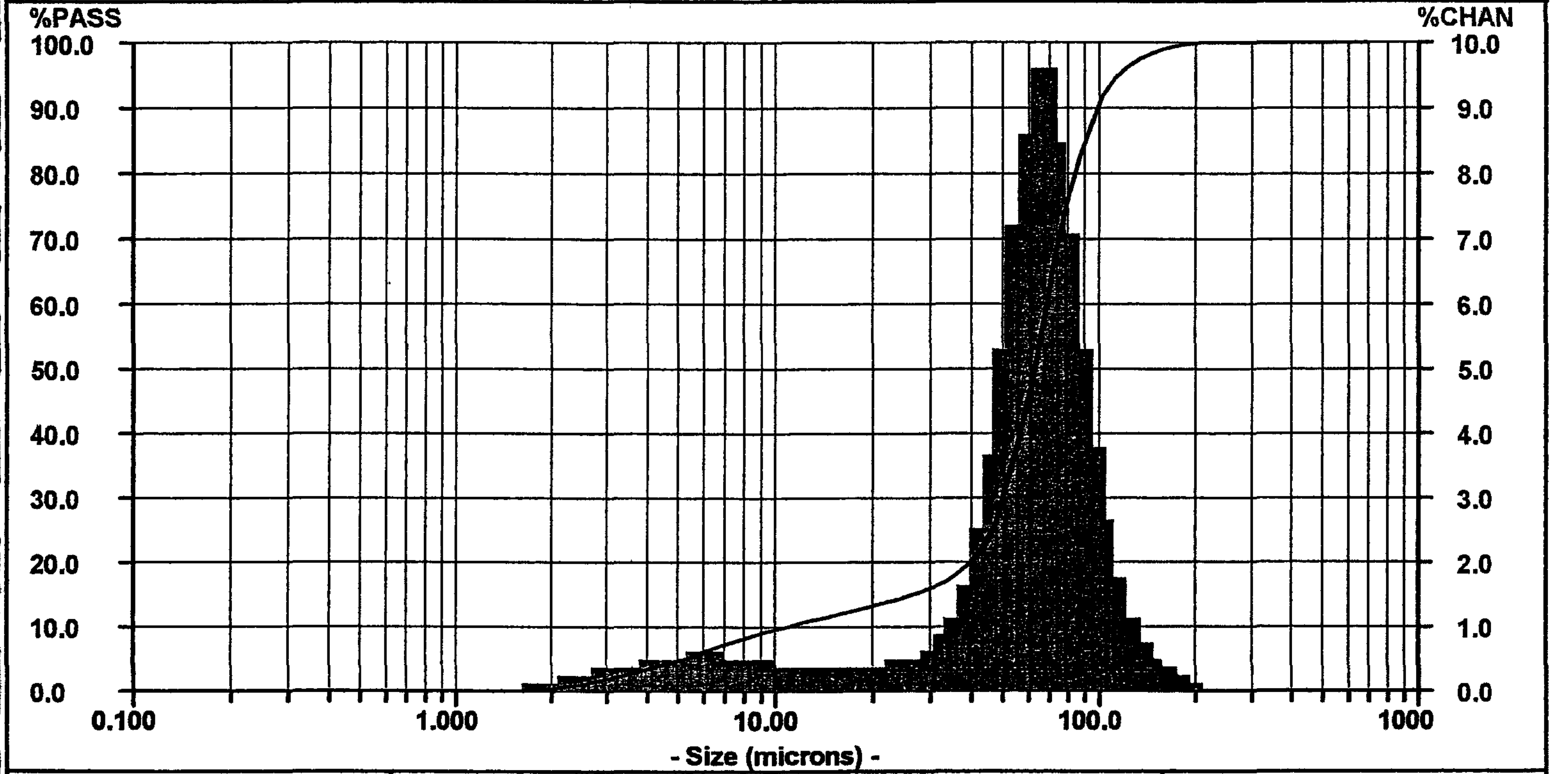
Ver:7.02

Carmeuse Tech Center	06-0239 Test 1-C	Date: 04/17/06 Meas #: 182 Time: 16:37 Pres #: 1

Codan Associates (5244 mgp)
Project: 5004
Test 1-C

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 62.79	10% = 10.78	60% = 69.48	66.51	90%	46.02
mn = 2.990	20% = 40.22	70% = 76.24	5.211	10%	5.541
ma = 25.54	30% = 50.98	80% = 85.10			
cs = 0.235	40% = 57.67	90% = 100.0			
sd = 29.79	50% = 63.57	95% = 116.1			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	75.51	8.52	9.250	9.12	0.55	1.060	0.00	0.00
645.6	100.00	0.00	74.00	66.99	9.63	8.482	8.57	0.59	0.972	0.00	0.00
592.0	100.00	0.00	67.86	57.36	9.68	7.778	7.98	0.62	0.892	0.00	0.00
542.9	100.00	0.00	62.23	47.68	8.69	7.133	7.36	0.64	0.818	0.00	0.00
497.8	100.00	0.00	57.06	38.99	7.24	6.541	6.72	0.64	0.750	0.00	0.00
456.5	100.00	0.00	52.33	31.75	5.33	5.998	6.08	0.64	0.688	0.00	0.00
418.6	100.00	0.00	47.98	26.42	3.79	5.500	5.44	0.61	0.630	0.00	0.00
383.9	100.00	0.00	44.00	22.63	2.56	5.044	4.83	0.58	0.578	0.00	0.00
352.0	100.00	0.00	40.35	20.07	1.72	4.625	4.25	0.54	0.530	0.00	0.00
322.8	100.00	0.00	37.00	18.35	1.22	4.241	3.71	0.51	0.486	0.00	0.00
296.0	100.00	0.00	33.93	17.13	0.90	3.889	3.20	0.48	0.446	0.00	0.00
271.4	100.00	0.00	31.11	16.23	0.71	3.566	2.72	0.45	0.409	0.00	0.00
248.9	100.00	0.00	28.53	15.52	0.61	3.270	2.27	0.42	0.375	0.00	0.00
228.2	100.00	0.00	26.16	14.91	0.55	2.999	1.85	0.38	0.344	0.00	0.00
209.3	100.00	0.18	23.99	14.36	0.51	2.750	1.47	0.35	0.315	0.00	0.00
191.9	99.82	0.31	22.00	13.85	0.50	2.522	1.12	0.30	0.289	0.00	0.00
176.0	99.51	0.40	20.17	13.35	0.48	2.312	0.82	0.26	0.265	0.00	0.00
161.4	99.11	0.57	18.50	12.87	0.47	2.121	0.56	0.22	0.243	0.00	0.00
148.0	98.54	0.84	16.96	12.40	0.47	1.945	0.34	0.20	0.223	0.00	0.00
135.7	97.70	1.25	15.56	11.93	0.46	1.783	0.14	0.14	0.204	0.00	0.00
124.5	96.45	1.84	14.27	11.47	0.45	1.635	0.00	0.00	0.187	0.00	0.00
114.1	94.61	2.72	13.08	11.02	0.45	1.499	0.00	0.00	0.172	0.00	0.00
104.7	91.89	3.91	12.00	10.57	0.46	1.375	0.00	0.00	0.158	0.00	0.00
95.96	87.98	5.37	11.00	10.11	0.48	1.261	0.00	0.00	0.145	0.00	0.00
88.00	82.61	7.10	10.09	9.63	0.51	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1596
Transmission: 0.94
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

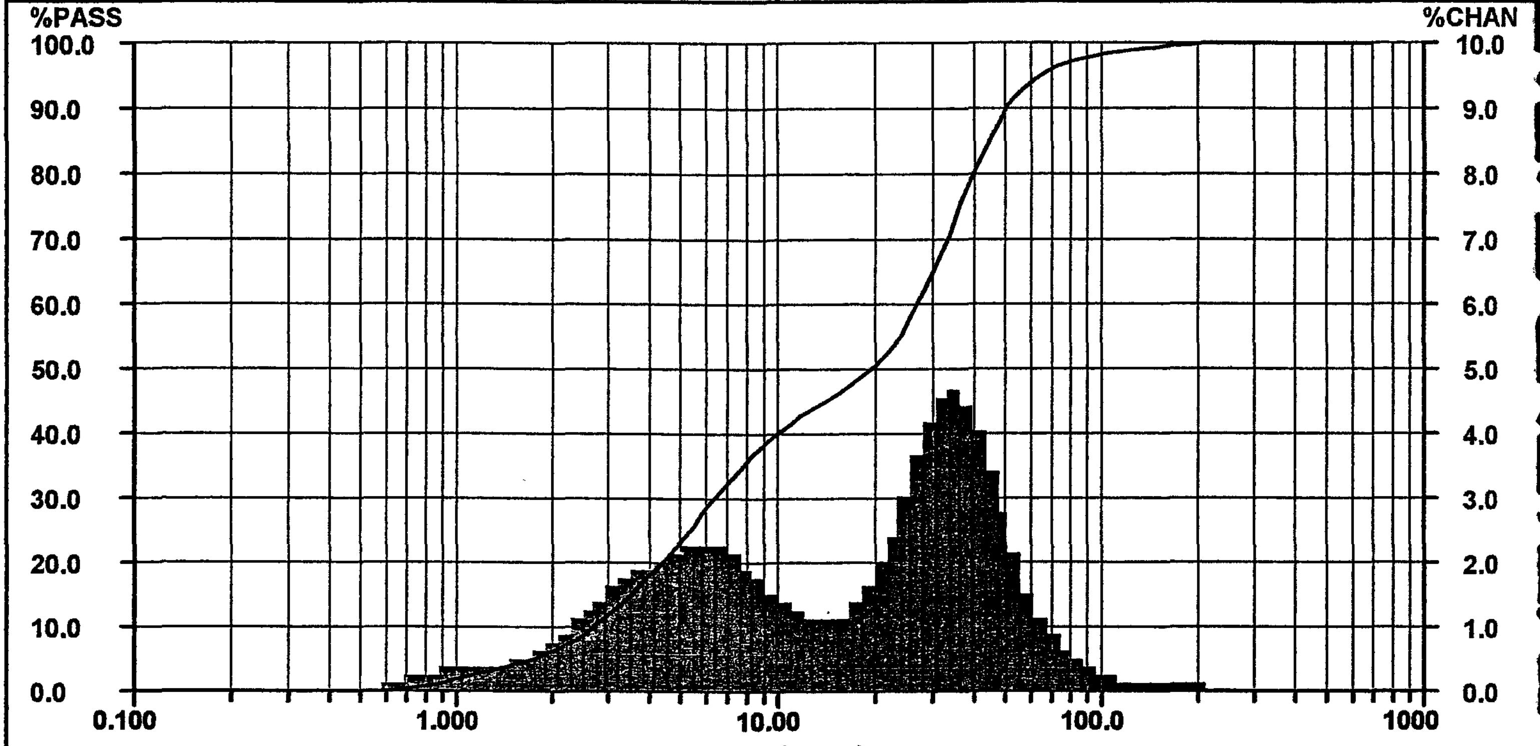
Ver:7.0

Carmeuse Tech Center	06-0240 Test 2-Fines	Date: 04/17/06 Meas #: 183 Time: 16:46 Pres #: 1

Codan Associates (5245 mgp)
Project: 5004
Test 2-Fines

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 24.70	10% = 2.723	60% = 27.25	34.65	56%	31.10
mn = 1.148	20% = 4.418	70% = 33.39	4.795	44%	6.375
ma = 6.587	30% = 6.470	80% = 40.23			
cs = 0.911	40% = 9.984	90% = 51.41			
sd = 20.02	50% = 19.51	95% = 64.95			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	97.17	0.69	9.250	38.60	1.81	1.060	2.22	0.44
645.6	100.00	0.00	74.00	96.48	0.91	8.482	36.79	2.00	0.972	1.78	0.41
592.0	100.00	0.00	67.86	95.57	1.22	7.778	34.79	2.19	0.892	1.37	0.37
542.9	100.00	0.00	62.23	94.35	1.64	7.133	32.60	2.30	0.818	1.00	0.32
497.8	100.00	0.00	57.06	92.71	2.16	6.541	30.30	2.35	0.750	0.68	0.27
456.5	100.00	0.00	52.33	90.55	2.81	5.998	27.95	2.35	0.688	0.41	0.25
418.6	100.00	0.00	47.98	87.74	3.47	5.500	25.60	2.28	0.630	0.16	0.16
383.9	100.00	0.00	44.00	84.27	4.11	5.044	23.32	2.20	0.578	0.00	0.00
352.0	100.00	0.00	40.35	80.16	4.54	4.625	21.12	2.09	0.530	0.00	0.00
322.8	100.00	0.00	37.00	75.62	4.74	4.241	19.03	2.00	0.486	0.00	0.00
296.0	100.00	0.00	33.93	70.88	4.63	3.889	17.03	1.90	0.446	0.00	0.00
271.4	100.00	0.00	31.11	66.25	4.23	3.566	15.13	1.79	0.409	0.00	0.00
248.9	100.00	0.00	28.53	62.02	3.70	3.270	13.34	1.67	0.375	0.00	0.00
228.2	100.00	0.00	26.16	58.32	3.08	2.999	11.67	1.51	0.344	0.00	0.00
209.3	100.00	0.13	23.99	55.24	2.52	2.750	10.16	1.33	0.315	0.00	0.00
191.9	99.87	0.19	22.00	52.72	2.04	2.522	8.83	1.15	0.289	0.00	0.00
176.0	99.68	0.17	20.17	50.68	1.67	2.312	7.68	0.96	0.265	0.00	0.00
161.4	99.51	0.17	18.50	49.01	1.42	2.121	6.72	0.81	0.243	0.00	0.00
148.0	99.34	0.19	16.96	47.59	1.25	1.945	5.91	0.68	0.223	0.00	0.00
135.7	99.15	0.21	15.56	46.34	1.16	1.783	5.23	0.59	0.204	0.00	0.00
124.5	98.94	0.24	14.27	45.18	1.14	1.635	4.64	0.53	0.187	0.00	0.00
114.1	98.70	0.27	13.08	44.04	1.17	1.499	4.11	0.49	0.172	0.00	0.00
104.7	98.43	0.33	12.00	42.87	1.27	1.375	3.62	0.48	0.158	0.00	0.00
95.96	98.10	0.41	11.00	41.60	1.41	1.261	3.14	0.46	0.145	0.00	0.00
88.00	97.69	0.52	10.09	40.19	1.59	1.156	2.68	0.46	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Database Path: C:\LT DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.0987
Transmission: 0.91
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

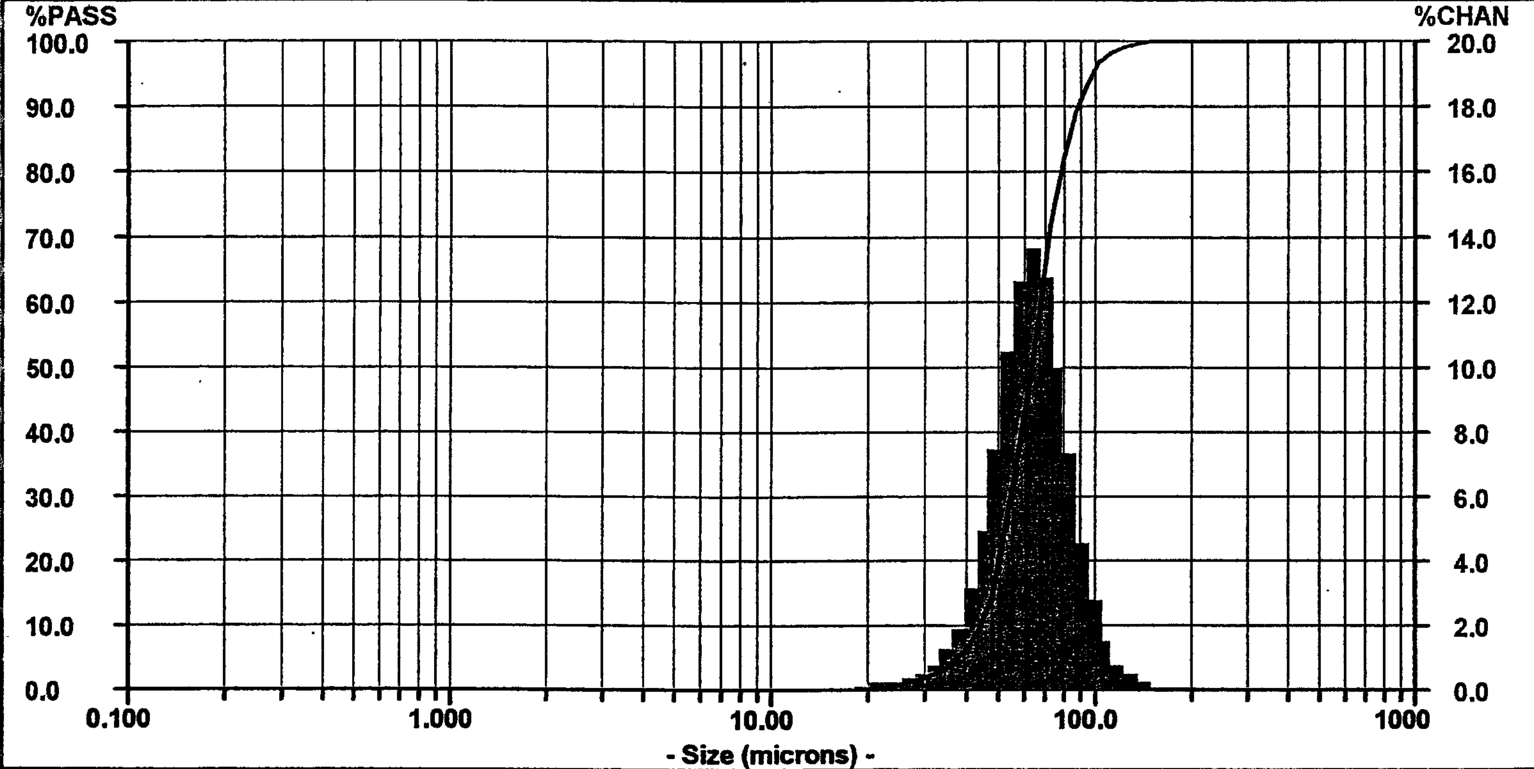
Ver:7.02

Carmeuse Tech Center	06-0241 Test 2-C	Date: 04/17/06 Meas #: 184 Time: 16:52 Pres #: 1

Codan Associates (5246 mgp)
Project: 5004
Test 2-C

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 65.76	10% = 44.47	60% = 68.35	64.16	100%	33.67
mn = 47.57	20% = 51.26	70% = 73.10			
ma = 60.35	30% = 55.96	80% = 79.35			
cs = 0.099	40% = 60.11	90% = 89.10			
sd = 16.83	50% = 64.16	95% = 98.83			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	81.86	10.10	9.250	0.00	0.00	1.060	0.00	0.00
645.6	100.00	0.00	74.00	71.76	12.84	8.482	0.00	0.00	0.972	0.00	0.00
592.0	100.00	0.00	67.86	58.92	13.70	7.778	0.00	0.00	0.892	0.00	0.00
542.9	100.00	0.00	62.23	45.22	12.67	7.133	0.00	0.00	0.818	0.00	0.00
497.8	100.00	0.00	57.06	32.55	10.59	6.541	0.00	0.00	0.750	0.00	0.00
456.5	100.00	0.00	52.33	21.96	7.47	5.998	0.00	0.00	0.688	0.00	0.00
418.6	100.00	0.00	47.98	14.49	5.04	5.500	0.00	0.00	0.630	0.00	0.00
383.9	100.00	0.00	44.00	9.45	3.17	5.044	0.00	0.00	0.578	0.00	0.00
352.0	100.00	0.00	40.35	6.28	1.96	4.625	0.00	0.00	0.530	0.00	0.00
322.8	100.00	0.00	37.00	4.32	1.29	4.241	0.00	0.00	0.486	0.00	0.00
296.0	100.00	0.00	33.93	3.03	0.86	3.889	0.00	0.00	0.446	0.00	0.00
271.4	100.00	0.00	31.11	2.17	0.62	3.566	0.00	0.00	0.409	0.00	0.00
248.9	100.00	0.00	28.53	1.55	0.47	3.270	0.00	0.00	0.375	0.00	0.00
228.2	100.00	0.00	26.16	1.08	0.36	2.999	0.00	0.00	0.344	0.00	0.00
209.3	100.00	0.00	23.99	0.72	0.30	2.750	0.00	0.00	0.315	0.00	0.00
191.9	100.00	0.00	22.00	0.42	0.26	2.522	0.00	0.00	0.289	0.00	0.00
176.0	100.00	0.00	20.17	0.16	0.16	2.312	0.00	0.00	0.265	0.00	0.00
161.4	100.00	0.00	18.50	0.00	0.00	2.121	0.00	0.00	0.243	0.00	0.00
148.0	100.00	0.26	16.96	0.00	0.00	1.945	0.00	0.00	0.223	0.00	0.00
135.7	99.74	0.53	15.56	0.00	0.00	1.783	0.00	0.00	0.204	0.00	0.00
124.5	99.21	0.88	14.27	0.00	0.00	1.635	0.00	0.00	0.187	0.00	0.00
114.1	98.33	1.60	13.08	0.00	0.00	1.499	0.00	0.00	0.172	0.00	0.00
104.7	96.73	2.80	12.00	0.00	0.00	1.375	0.00	0.00	0.158	0.00	0.00
95.96	93.93	4.67	11.00	0.00	0.00	1.261	0.00	0.00	0.145	0.00	0.00
88.00	89.26	7.40	10.09	0.00	0.00	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Database Path: C:\LT DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1059
Transmission: 0.96
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

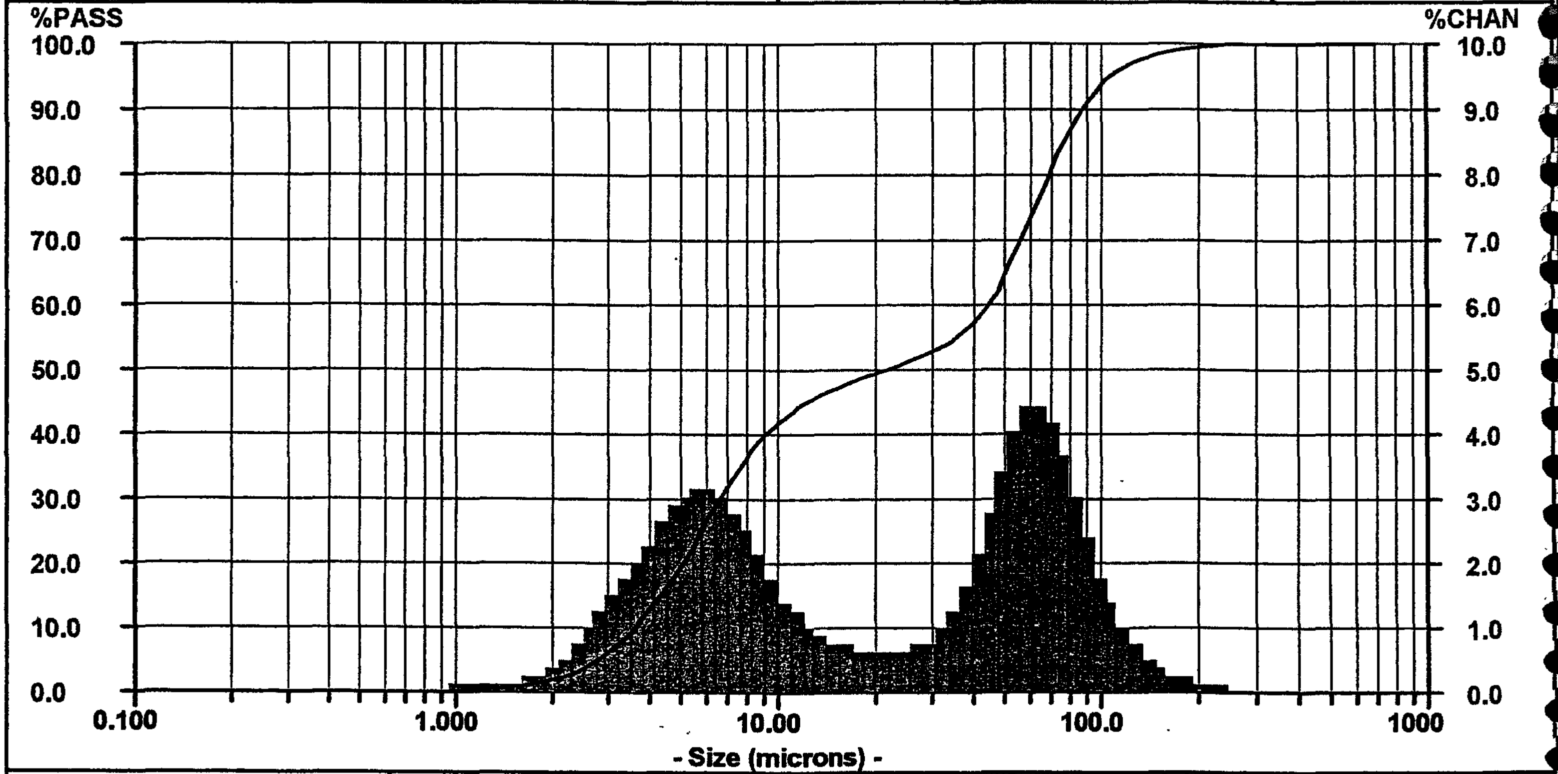
Ver:7.02

Carmeuse Tech Center	06-0242 U1B-O	Date: 04/17/06 Meas #: 185 Time: 17:01 Pres #: 1

Codan Associates (5247 mgp)
Project: 5004
U1B-O

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 37.95	10% = 3.653	60% = 44.69	62.18	51%	53.13
mn = 2.354	20% = 5.111	70% = 57.04	5.769	49%	6.417
ma = 8.992	30% = 6.680	80% = 69.16			
cs = 0.667	40% = 9.246	90% = 87.52			
sd = 35.29	50% = 21.29	95% = 107.6			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	87.07	3.73	9.250	40.01	2.18	1.060	0.14	0.14
645.6	100.00	0.00	74.00	83.34	4.29	8.482	37.83	2.55	0.972	0.00	0.00
592.0	100.00	0.00	67.86	79.05	4.55	7.778	35.28	2.90	0.892	0.00	0.00
542.9	100.00	0.00	62.23	74.50	4.48	7.133	32.38	3.15	0.818	0.00	0.00
497.8	100.00	0.00	57.06	70.02	4.13	6.541	29.23	3.28	0.750	0.00	0.00
456.5	100.00	0.00	52.33	65.89	3.51	5.998	25.95	3.28	0.688	0.00	0.00
418.6	100.00	0.00	47.98	62.38	2.86	5.500	22.67	3.14	0.630	0.00	0.00
383.9	100.00	0.00	44.00	59.52	2.21	5.044	19.53	2.93	0.578	0.00	0.00
352.0	100.00	0.00	40.35	57.31	1.70	4.625	16.60	2.66	0.530	0.00	0.00
322.8	100.00	0.00	37.00	55.61	1.32	4.241	13.94	2.39	0.486	0.00	0.00
296.0	100.00	0.00	33.93	54.29	1.05	3.889	11.55	2.11	0.446	0.00	0.00
271.4	100.00	0.00	31.11	53.24	0.87	3.566	9.44	1.84	0.409	0.00	0.00
248.9	100.00	0.14	28.53	52.37	0.76	3.270	7.60	1.57	0.375	0.00	0.00
228.2	99.86	0.21	26.16	51.61	0.70	2.999	6.03	1.30	0.344	0.00	0.00
209.3	99.65	0.23	23.99	50.91	0.66	2.750	4.73	1.04	0.315	0.00	0.00
191.9	99.42	0.27	22.00	50.25	0.66	2.522	3.69	0.82	0.289	0.00	0.00
176.0	99.15	0.34	20.17	49.59	0.67	2.312	2.87	0.62	0.265	0.00	0.00
161.4	98.81	0.45	18.50	48.92	0.71	2.121	2.25	0.47	0.243	0.00	0.00
148.0	98.36	0.59	16.96	48.21	0.76	1.945	1.78	0.36	0.223	0.00	0.00
135.7	97.77	0.78	15.56	47.45	0.83	1.783	1.42	0.29	0.204	0.00	0.00
124.5	96.99	1.05	14.27	46.62	0.94	1.635	1.13	0.24	0.187	0.00	0.00
114.1	95.94	1.41	13.08	45.68	1.07	1.499	0.89	0.20	0.172	0.00	0.00
104.7	94.53	1.89	12.00	44.61	1.27	1.375	0.69	0.18	0.158	0.00	0.00
95.96	92.64	2.45	11.00	43.34	1.51	1.261	0.51	0.18	0.145	0.00	0.00
88.00	90.19	3.12	10.09	41.83	1.82	1.156	0.33	0.19	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1747
Transmission: 0.88
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

Database Path: C:\LT_DATA\5004.DB

LECOTRAC - LT100

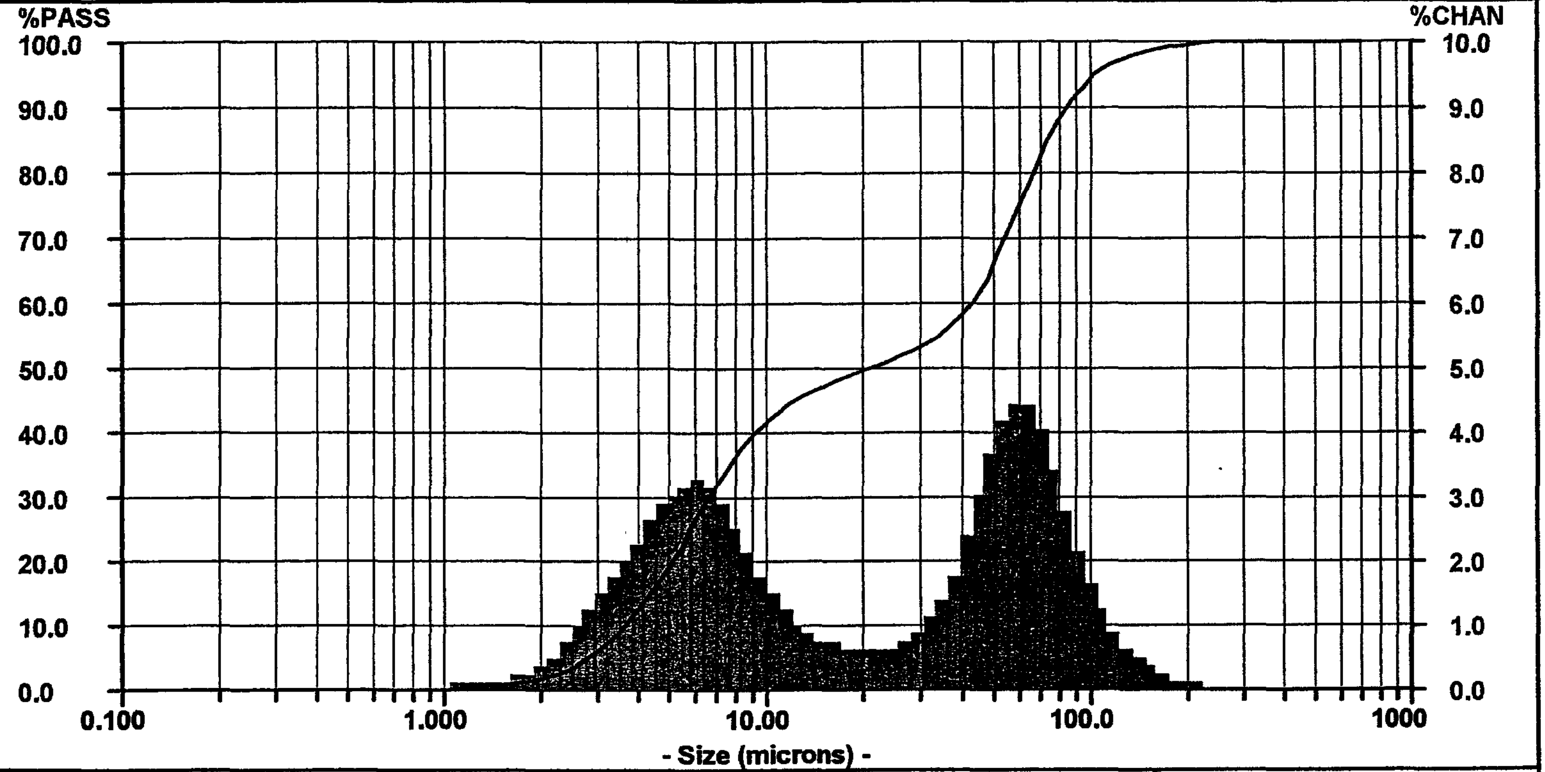
Ver:7.02

Carmeuse Tech Center	06-0243 U1B-P	Date: 04/18/06 Meas #: 186 Time: 15:26 Pres #: 1

Codan Associates (5248 mgp)
Project: 5004
U1B-P

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 36.84	10% = 3.686	60% = 43.03	60.31	51%	51.62
mn = 2.398	20% = 5.145	70% = 55.18	5.816	49%	6.483
ma = 9.040	30% = 6.715	80% = 67.02			
cs = 0.664	40% = 9.284	90% = 84.80			
sd = 34.11	50% = 20.70	95% = 104.0			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	88.28	3.51	9.250	39.92	2.22	1.060	0.12	0.12
645.6	100.00	0.00	74.00	84.77	4.12	8.482	37.70	2.57	0.972	0.00	0.00
592.0	100.00	0.00	67.86	80.65	4.46	7.778	35.13	2.93	0.892	0.00	0.00
542.9	100.00	0.00	62.23	76.19	4.50	7.133	32.20	3.17	0.818	0.00	0.00
497.8	100.00	0.00	57.06	71.69	4.24	6.541	29.03	3.30	0.750	0.00	0.00
456.5	100.00	0.00	52.33	67.45	3.70	5.998	25.73	3.29	0.688	0.00	0.00
418.6	100.00	0.00	47.98	63.75	3.08	5.500	22.44	3.14	0.630	0.00	0.00
383.9	100.00	0.00	44.00	60.67	2.42	5.044	19.30	2.93	0.578	0.00	0.00
352.0	100.00	0.00	40.35	58.25	1.88	4.625	16.37	2.66	0.530	0.00	0.00
322.8	100.00	0.00	37.00	56.37	1.47	4.241	13.71	2.38	0.486	0.00	0.00
296.0	100.00	0.00	33.93	54.90	1.16	3.889	11.33	2.10	0.446	0.00	0.00
271.4	100.00	0.00	31.11	53.74	0.96	3.566	9.23	1.83	0.409	0.00	0.00
248.9	100.00	0.12	28.53	52.78	0.83	3.270	7.40	1.55	0.375	0.00	0.00
228.2	99.88	0.19	26.16	51.95	0.75	2.999	5.85	1.29	0.344	0.00	0.00
209.3	99.69	0.20	23.99	51.20	0.71	2.750	4.56	1.02	0.315	0.00	0.00
191.9	99.49	0.24	22.00	50.49	0.69	2.522	3.54	0.80	0.289	0.00	0.00
176.0	99.25	0.30	20.17	49.80	0.71	2.312	2.74	0.60	0.265	0.00	0.00
161.4	98.95	0.40	18.50	49.09	0.74	2.121	2.14	0.46	0.243	0.00	0.00
148.0	98.55	0.52	16.96	48.35	0.79	1.945	1.68	0.35	0.223	0.00	0.00
135.7	98.03	0.70	15.56	47.56	0.86	1.783	1.33	0.27	0.204	0.00	0.00
124.5	97.33	0.94	14.27	46.70	0.97	1.635	1.06	0.23	0.187	0.00	0.00
114.1	96.39	1.27	13.08	45.73	1.11	1.499	0.83	0.19	0.172	0.00	0.00
104.7	95.12	1.71	12.00	44.62	1.30	1.375	0.64	0.17	0.158	0.00	0.00
95.96	93.41	2.24	11.00	43.32	1.55	1.261	0.47	0.17	0.145	0.00	0.00
88.00	91.17	2.89	10.09	41.77	1.85	1.156	0.30	0.18	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1860
Transmission: 0.87
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

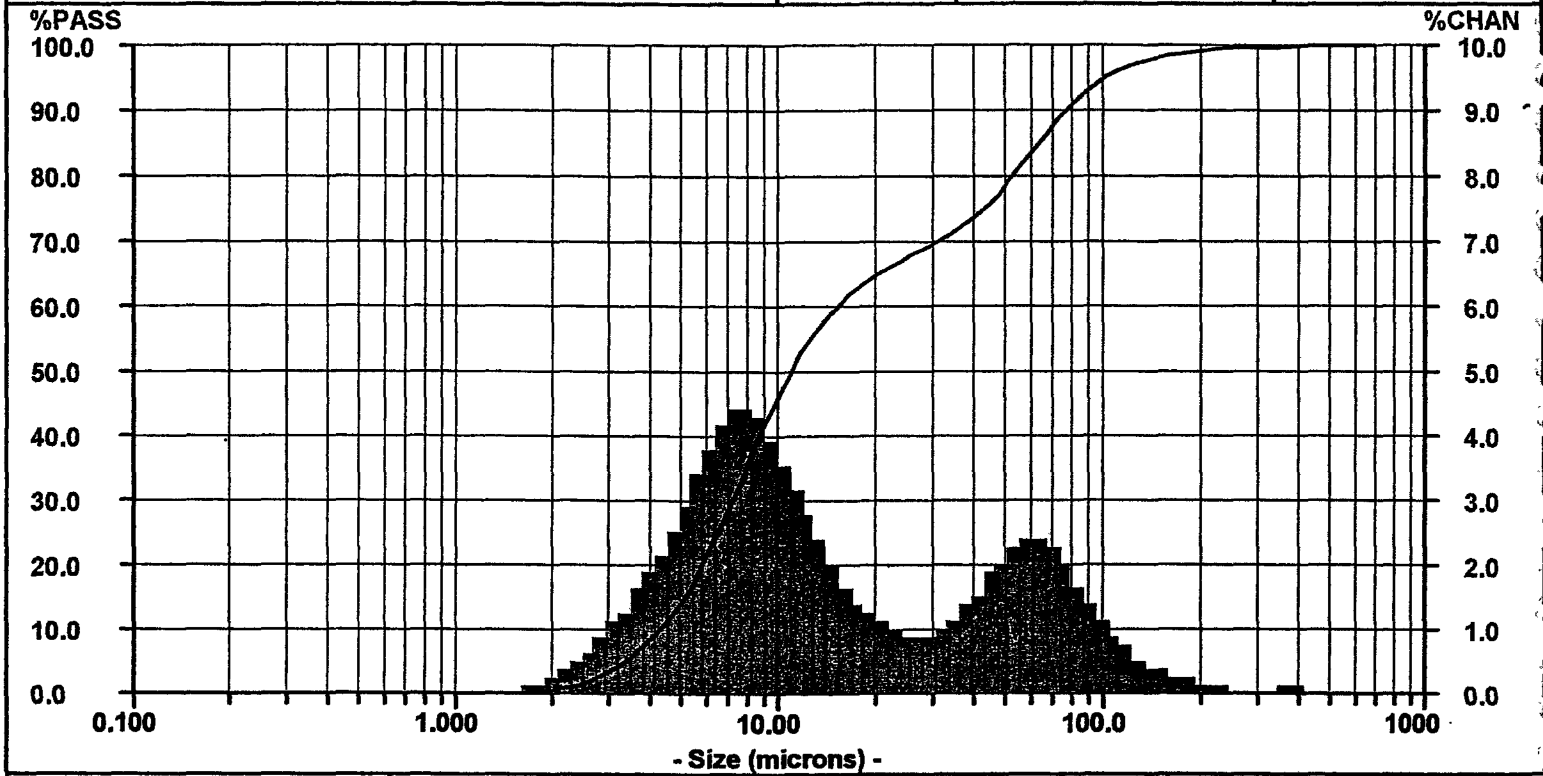
Ver:7.0

Carmeuse Tech Center	06-0244 U1C-O	Date: 04/18/06 Meas #: 190 Time: 15:42 Pres #: 1

Codan Associates (5249 mgp)
Project: 5004
U1C-O

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 29.74	10% = 4.365	60% = 15.37	61.99	32%	62.31
mn = 3.812	20% = 5.904	70% = 31.16	7.901	68%	9.188
ma = 9.381	30% = 7.308	80% = 53.67			
cs = 0.640	40% = 8.879	90% = 77.69			
sd = 28.32	50% = 11.07	95% = 102.3			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	90.87	2.04	9.250	42.03	4.34	1.060	0.00	0.00
645.6	100.00	0.00	74.00	88.83	2.29	8.482	37.69	4.48	0.972	0.00	0.00
592.0	100.00	0.00	67.86	86.54	2.42	7.778	33.21	4.44	0.892	0.00	0.00
542.9	100.00	0.00	62.23	84.12	2.44	7.133	28.77	4.23	0.818	0.00	0.00
497.8	100.00	0.00	57.06	81.68	2.35	6.541	24.54	3.88	0.750	0.00	0.00
456.5	100.00	0.00	52.33	79.33	2.14	5.998	20.66	3.47	0.688	0.00	0.00
418.6	100.00	0.15	47.98	77.19	1.90	5.500	17.19	3.03	0.630	0.00	0.00
383.9	99.85	0.15	44.00	75.29	1.62	5.044	14.16	2.62	0.578	0.00	0.00
352.0	99.70	0.00	40.35	73.67	1.40	4.625	11.54	2.25	0.530	0.00	0.00
322.8	99.70	0.00	37.00	72.27	1.21	4.241	9.29	1.93	0.486	0.00	0.00
296.0	99.70	0.00	33.93	71.06	1.08	3.889	7.36	1.65	0.446	0.00	0.00
271.4	99.70	0.00	31.11	69.98	1.00	3.566	5.71	1.38	0.409	0.00	0.00
248.9	99.70	0.14	28.53	68.98	0.96	3.270	4.33	1.14	0.375	0.00	0.00
228.2	99.56	0.22	26.16	68.02	0.98	2.999	3.19	0.92	0.344	0.00	0.00
209.3	99.34	0.23	23.99	67.04	1.05	2.750	2.27	0.71	0.315	0.00	0.00
191.9	99.11	0.26	22.00	65.99	1.15	2.522	1.56	0.53	0.289	0.00	0.00
176.0	98.85	0.32	20.17	64.84	1.30	2.312	1.03	0.39	0.265	0.00	0.00
161.4	98.53	0.40	18.50	63.54	1.50	2.121	0.64	0.28	0.243	0.00	0.00
148.0	98.13	0.49	16.96	62.04	1.76	1.945	0.36	0.22	0.223	0.00	0.00
135.7	97.64	0.61	15.56	60.28	2.06	1.783	0.14	0.14	0.204	0.00	0.00
124.5	97.03	0.77	14.27	58.22	2.42	1.635	0.00	0.00	0.187	0.00	0.00
114.1	96.26	0.96	13.08	55.80	2.81	1.499	0.00	0.00	0.172	0.00	0.00
104.7	95.30	1.20	12.00	52.99	3.24	1.375	0.00	0.00	0.158	0.00	0.00
95.96	94.10	1.47	11.00	49.75	3.67	1.261	0.00	0.00	0.145	0.00	0.00
88.00	92.63	1.76	10.09	46.08	4.05	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Database Path: C:\LT DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.2051
Transmission: 0.86
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

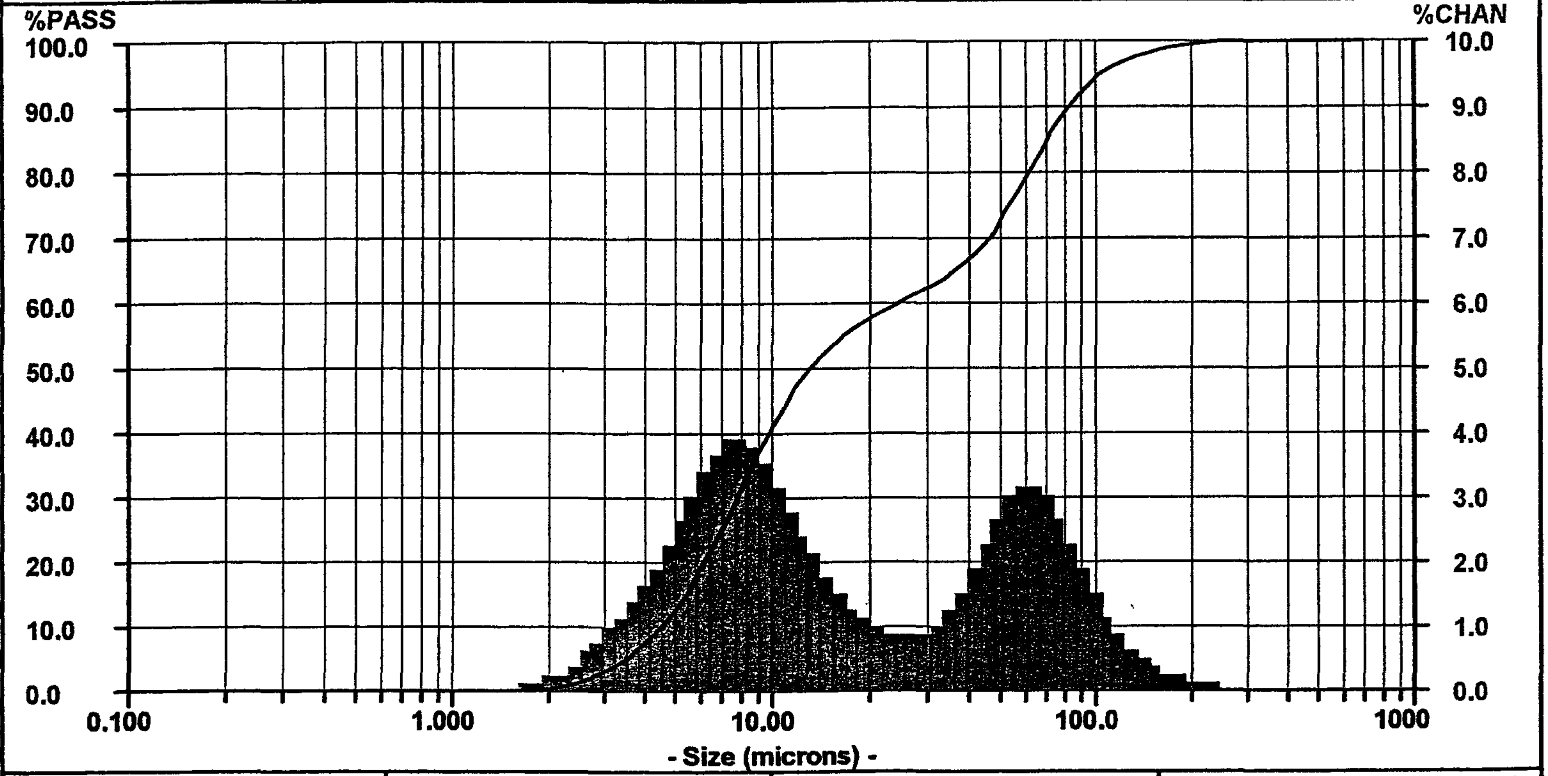
Ver:7.02

Carmeuse Tech Center	06-0245 U1C-P	Date: 04/18/06 Meas #: 191 Time: 15:48 Pres #: 1

Codan Associates (5250 mgp)
Project: 5004
U1C-P

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 33.27	10% = 4.554	60% = 24.21	61.33	41%	58.31
mn = 3.784	20% = 6.220	70% = 46.32	7.728	59%	8.552
ma = 10.29	30% = 7.820	80% = 62.20			
cs = 0.583	40% = 9.821	90% = 83.16			
sd = 31.80	50% = 13.25	95% = 105.0			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	89.15	2.75	9.250	37.53	3.82	1.060	0.00	0.00
645.6	100.00	0.00	74.00	86.40	3.11	8.482	33.71	3.95	0.972	0.00	0.00
592.0	100.00	0.00	67.86	83.29	3.27	7.778	29.76	3.94	0.892	0.00	0.00
542.9	100.00	0.00	62.23	80.02	3.26	7.133	25.82	3.77	0.818	0.00	0.00
497.8	100.00	0.00	57.06	76.76	3.06	6.541	22.05	3.47	0.750	0.00	0.00
456.5	100.00	0.00	52.33	73.70	2.71	5.998	18.58	3.12	0.688	0.00	0.00
418.6	100.00	0.00	47.98	70.99	2.32	5.500	15.46	2.72	0.630	0.00	0.00
383.9	100.00	0.00	44.00	68.67	1.90	5.044	12.74	2.36	0.578	0.00	0.00
352.0	100.00	0.00	40.35	66.77	1.57	4.625	10.38	2.02	0.530	0.00	0.00
322.8	100.00	0.00	37.00	65.20	1.30	4.241	8.36	1.72	0.486	0.00	0.00
296.0	100.00	0.00	33.93	63.90	1.12	3.889	6.64	1.47	0.446	0.00	0.00
271.4	100.00	0.00	31.11	62.78	1.00	3.566	5.17	1.23	0.409	0.00	0.00
248.9	100.00	0.14	28.53	61.78	0.94	3.270	3.94	1.02	0.375	0.00	0.00
228.2	99.86	0.22	26.16	60.84	0.94	2.999	2.92	0.82	0.344	0.00	0.00
209.3	99.64	0.23	23.99	59.90	0.98	2.750	2.10	0.64	0.315	0.00	0.00
191.9	99.41	0.28	22.00	58.92	1.07	2.522	1.46	0.49	0.289	0.00	0.00
176.0	99.13	0.35	20.17	57.85	1.20	2.312	0.97	0.36	0.265	0.00	0.00
161.4	98.78	0.43	18.50	56.65	1.38	2.121	0.61	0.26	0.243	0.00	0.00
148.0	98.35	0.55	16.96	55.27	1.59	1.945	0.35	0.22	0.223	0.00	0.00
135.7	97.80	0.72	15.56	53.68	1.85	1.783	0.13	0.13	0.204	0.00	0.00
124.5	97.08	0.92	14.27	51.83	2.16	1.635	0.00	0.00	0.187	0.00	0.00
114.1	96.16	1.20	13.08	49.67	2.49	1.499	0.00	0.00	0.172	0.00	0.00
104.7	94.96	1.53	12.00	47.18	2.86	1.375	0.00	0.00	0.158	0.00	0.00
95.96	93.43	1.92	11.00	44.32	3.23	1.261	0.00	0.00	0.145	0.00	0.00
88.00	91.51	2.36	10.09	41.09	3.56	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.2334
Transmission: 0.85
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

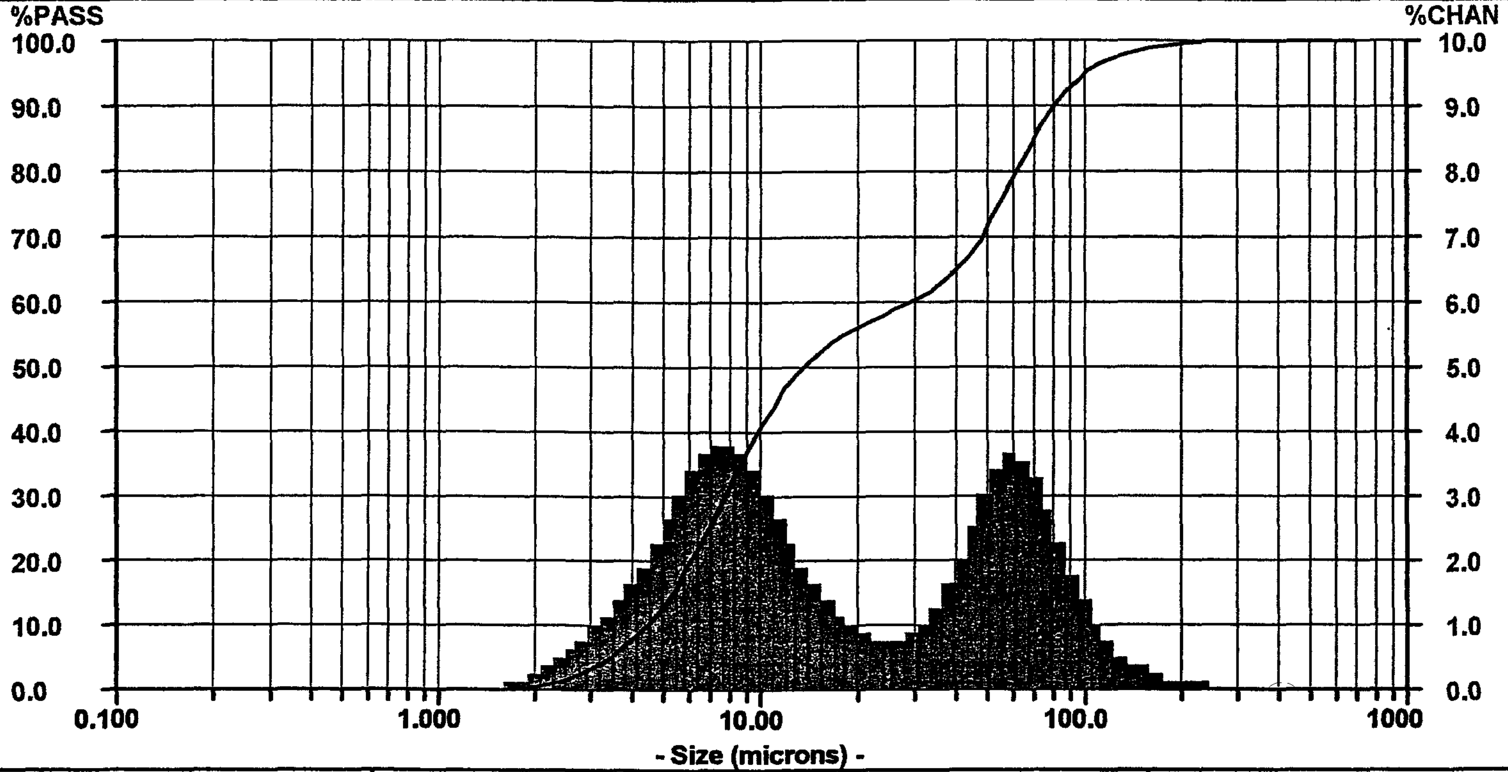
Ver:7.0

Carmeuse Tech Center	06-0246 U1D-O	Date: 04/18/06 Meas #: 192 Time: 15:55 Pres #: 1

Codan Associates (5251 mgp)
Project: 5004
U1D-O

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 33.57	10% = 4.509	60% = 29.20	60.34	43%	53.11
mn = 3.721	20% = 6.193	70% = 48.56	7.572	57%	8.291
ma = 10.33	30% = 7.814	80% = 62.36			
cs = 0.581	40% = 9.881	90% = 81.33			
sd = 31.55	50% = 13.69	95% = 101.4			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	89.78	2.88	9.250	37.38	3.72	1.060	0.00	0.00
645.6	100.00	0.00	74.00	86.90	3.36	8.482	33.66	3.86	0.972	0.00	0.00
592.0	100.00	0.00	67.86	83.54	3.63	7.778	29.80	3.87	0.892	0.00	0.00
542.9	100.00	0.00	62.23	79.91	3.69	7.133	25.93	3.73	0.818	0.00	0.00
497.8	100.00	0.00	57.06	76.22	3.52	6.541	22.20	3.44	0.750	0.00	0.00
456.5	100.00	0.00	52.33	72.70	3.11	5.998	18.76	3.09	0.688	0.00	0.00
418.6	100.00	0.00	47.98	69.59	2.63	5.500	15.67	2.70	0.630	0.00	0.00
383.9	100.00	0.00	44.00	66.96	2.11	5.044	12.97	2.35	0.578	0.00	0.00
352.0	100.00	0.00	40.35	64.85	1.68	4.625	10.62	2.02	0.530	0.00	0.00
322.8	100.00	0.00	37.00	63.17	1.35	4.241	8.60	1.73	0.486	0.00	0.00
296.0	100.00	0.00	33.93	61.82	1.11	3.889	6.87	1.48	0.446	0.00	0.00
271.4	100.00	0.00	31.11	60.71	0.96	3.566	5.39	1.26	0.409	0.00	0.00
248.9	100.00	0.13	28.53	59.75	0.87	3.270	4.13	1.05	0.375	0.00	0.00
228.2	99.87	0.20	26.16	58.88	0.84	2.999	3.08	0.85	0.344	0.00	0.00
209.3	99.67	0.21	23.99	58.04	0.87	2.750	2.23	0.67	0.315	0.00	0.00
191.9	99.46	0.24	22.00	57.17	0.93	2.522	1.56	0.52	0.289	0.00	0.00
176.0	99.22	0.30	20.17	56.24	1.05	2.312	1.04	0.38	0.265	0.00	0.00
161.4	98.92	0.38	18.50	55.19	1.21	2.121	0.66	0.29	0.243	0.00	0.00
148.0	98.54	0.49	16.96	53.98	1.42	1.945	0.37	0.23	0.223	0.00	0.00
135.7	98.05	0.63	15.56	52.56	1.67	1.783	0.14	0.14	0.204	0.00	0.00
124.5	97.42	0.83	14.27	50.89	1.97	1.635	0.00	0.00	0.187	0.00	0.00
114.1	96.59	1.10	13.08	48.92	2.32	1.499	0.00	0.00	0.172	0.00	0.00
104.7	95.49	1.45	12.00	46.60	2.70	1.375	0.00	0.00	0.158	0.00	0.00
95.96	94.04	1.88	11.00	43.90	3.09	1.261	0.00	0.00	0.145	0.00	0.00
88.00	92.16	2.38	10.09	40.81	3.43	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Database Path: C:\LT DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1291
Transmission: 0.91
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

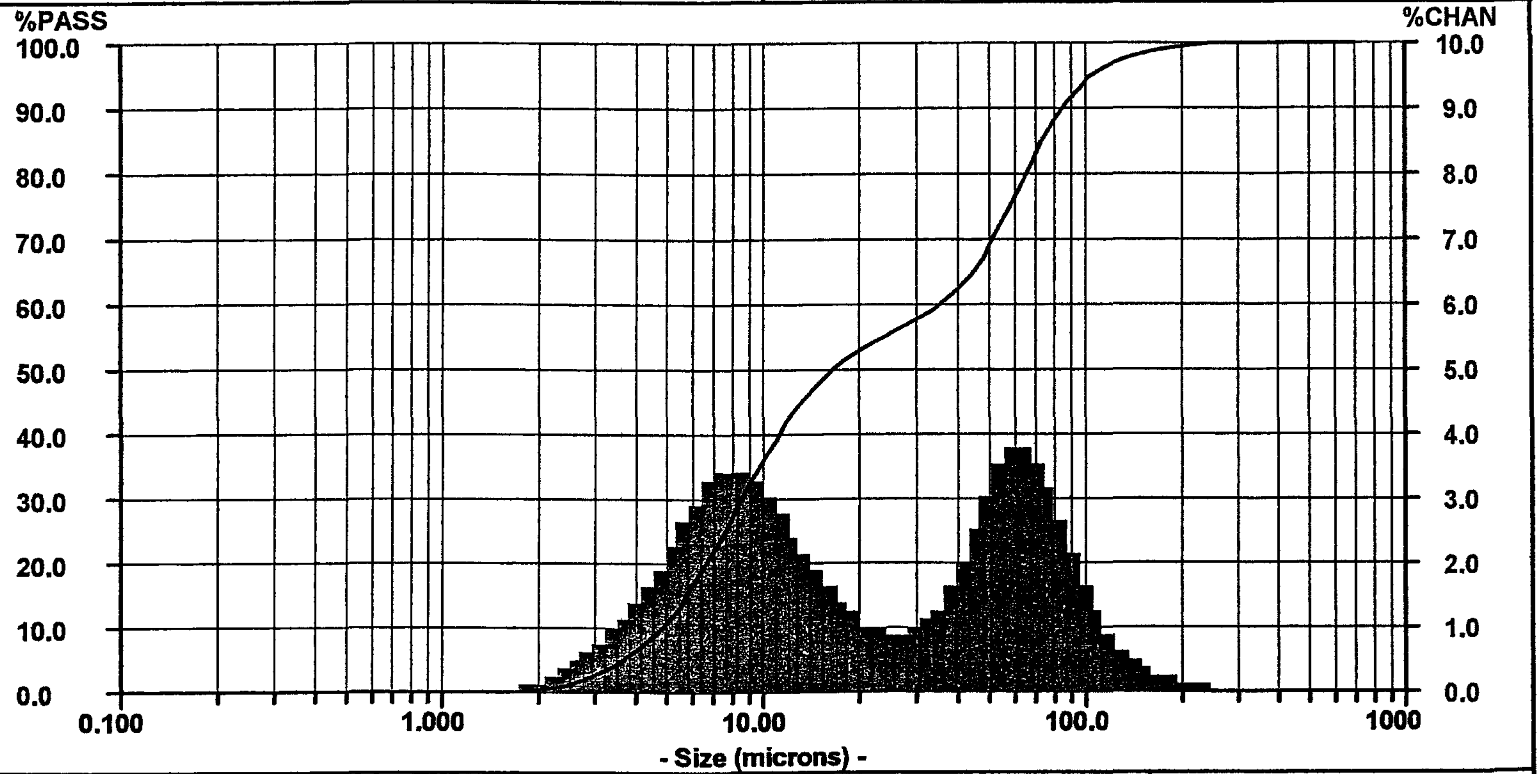
Ver:7.02

Carmeuse Tech Center	06-0247 U1D-P	Date: 04/18/06 Meas #: 193 Time: 16:02 Pres #: 1

Codan Associates (5252 mgp)
Project: 5004
U1D-P

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 36.08	10% = 4.850	60% = 35.52	63.15	44%	53.50
mn = 3.801	20% = 6.717	70% = 52.23	8.233	56%	9.957
ma = 11.31	30% = 8.628	80% = 65.90			
cs = 0.531	40% = 11.29	90% = 85.34			
sd = 33.15	50% = 16.68	95% = 105.8			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	88.20	3.23	9.250	32.79	3.47	1.060	0.00	0.00
645.6	100.00	0.00	74.00	84.97	3.66	8.482	29.32	3.53	0.972	0.00	0.00
592.0	100.00	0.00	67.86	81.31	3.86	7.778	25.79	3.48	0.892	0.00	0.00
542.9	100.00	0.00	62.23	77.45	3.82	7.133	22.31	3.30	0.818	0.00	0.00
497.8	100.00	0.00	57.06	73.63	3.56	6.541	19.01	3.02	0.750	0.00	0.00
456.5	100.00	0.00	52.33	70.07	3.08	5.998	15.99	2.70	0.688	0.00	0.00
418.6	100.00	0.00	47.98	66.99	2.59	5.500	13.29	2.34	0.630	0.00	0.00
383.9	100.00	0.00	44.00	64.40	2.07	5.044	10.95	2.02	0.578	0.00	0.00
352.0	100.00	0.00	40.35	62.33	1.66	4.625	8.93	1.72	0.530	0.00	0.00
322.8	100.00	0.00	37.00	60.67	1.36	4.241	7.21	1.47	0.486	0.00	0.00
296.0	100.00	0.00	33.93	59.31	1.14	3.889	5.74	1.25	0.446	0.00	0.00
271.4	100.00	0.00	31.11	58.17	1.02	3.566	4.49	1.05	0.409	0.00	0.00
248.9	100.00	0.13	28.53	57.15	0.96	3.270	3.44	0.87	0.375	0.00	0.00
228.2	99.87	0.20	26.16	56.19	0.97	2.999	2.57	0.71	0.344	0.00	0.00
209.3	99.67	0.22	23.99	55.22	1.02	2.750	1.86	0.55	0.315	0.00	0.00
191.9	99.45	0.26	22.00	54.20	1.13	2.522	1.31	0.43	0.289	0.00	0.00
176.0	99.19	0.33	20.17	53.07	1.27	2.312	0.88	0.32	0.265	0.00	0.00
161.4	98.86	0.43	18.50	51.80	1.47	2.121	0.56	0.24	0.243	0.00	0.00
148.0	98.43	0.56	16.96	50.33	1.70	1.945	0.32	0.20	0.223	0.00	0.00
135.7	97.87	0.74	15.56	48.63	1.95	1.783	0.12	0.12	0.204	0.00	0.00
124.5	97.13	0.98	14.27	46.68	2.22	1.635	0.00	0.00	0.187	0.00	0.00
114.1	96.15	1.31	13.08	44.46	2.51	1.499	0.00	0.00	0.172	0.00	0.00
104.7	94.84	1.72	12.00	41.95	2.79	1.375	0.00	0.00	0.158	0.00	0.00
95.96	93.12	2.19	11.00	39.16	3.07	1.261	0.00	0.00	0.145	0.00	0.00
88.00	90.93	2.73	10.09	36.09	3.30	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1755
Transmission: 0.89
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

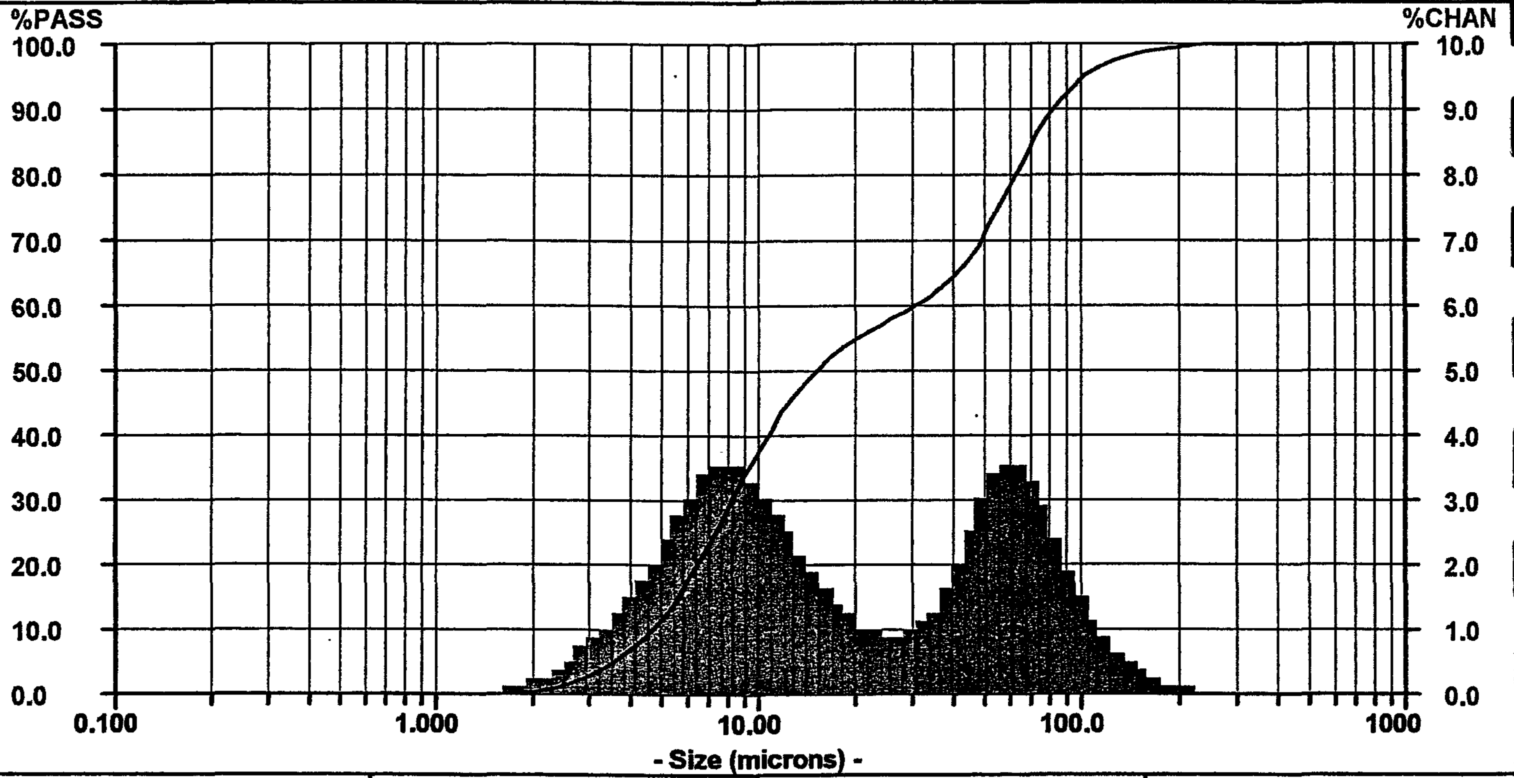
Ver:7.0

Carmeuse Tech Center	06-0248 U1E-O	Date: 04/18/06 Meas #: 194 Time: 16:10 Pres #: 1

Codan Associates (5253 mgp)
Project: 5004
U1E-O

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 34.44	10% = 4.717	60% = 30.79	60.55	44%	54.94
mn = 3.772	20% = 6.529	70% = 49.33	7.960	56%	8.988
ma = 10.88	30% = 8.338	80% = 63.40			
cs = 0.551	40% = 10.74	90% = 82.83			
sd = 32.00	50% = 15.21	95% = 103.2			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	89.22	2.96	9.250	34.31	3.58	1.060	0.00	0.00
645.6	100.00	0.00	74.00	86.26	3.40	8.482	30.73	3.64	0.972	0.00	0.00
592.0	100.00	0.00	67.86	82.86	3.64	7.778	27.09	3.60	0.892	0.00	0.00
542.9	100.00	0.00	62.23	79.22	3.65	7.133	23.49	3.42	0.818	0.00	0.00
497.8	100.00	0.00	57.06	75.57	3.46	6.541	20.07	3.14	0.750	0.00	0.00
456.5	100.00	0.00	52.33	72.11	3.04	5.998	16.93	2.81	0.688	0.00	0.00
418.6	100.00	0.00	47.98	69.07	2.59	5.500	14.12	2.46	0.630	0.00	0.00
383.9	100.00	0.00	44.00	66.48	2.09	5.044	11.66	2.12	0.578	0.00	0.00
352.0	100.00	0.00	40.35	64.39	1.70	4.625	9.54	1.82	0.530	0.00	0.00
322.8	100.00	0.00	37.00	62.69	1.39	4.241	7.72	1.56	0.486	0.00	0.00
296.0	100.00	0.00	33.93	61.30	1.17	3.889	6.16	1.33	0.446	0.00	0.00
271.4	100.00	0.00	31.11	60.13	1.04	3.566	4.83	1.13	0.409	0.00	0.00
248.9	100.00	0.12	28.53	59.09	0.98	3.270	3.70	0.94	0.375	0.00	0.00
228.2	99.88	0.19	26.16	58.11	0.98	2.999	2.76	0.76	0.344	0.00	0.00
209.3	99.69	0.20	23.99	57.13	1.03	2.750	2.00	0.60	0.315	0.00	0.00
191.9	99.49	0.25	22.00	56.10	1.13	2.522	1.40	0.46	0.289	0.00	0.00
176.0	99.24	0.31	20.17	54.97	1.28	2.312	0.94	0.34	0.265	0.00	0.00
161.4	98.93	0.40	18.50	53.69	1.48	2.121	0.60	0.26	0.243	0.00	0.00
148.0	98.53	0.52	16.96	52.21	1.70	1.945	0.34	0.21	0.223	0.00	0.00
135.7	98.01	0.68	15.56	50.51	1.97	1.783	0.13	0.13	0.204	0.00	0.00
124.5	97.33	0.90	14.27	48.54	2.25	1.635	0.00	0.00	0.187	0.00	0.00
114.1	96.43	1.18	13.08	46.29	2.56	1.499	0.00	0.00	0.172	0.00	0.00
104.7	95.25	1.55	12.00	43.73	2.86	1.375	0.00	0.00	0.158	0.00	0.00
95.96	93.70	1.99	11.00	40.87	3.16	1.261	0.00	0.00	0.145	0.00	0.00
88.00	91.71	2.49	10.09	37.71	3.40	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1888
Transmission: 0.88
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

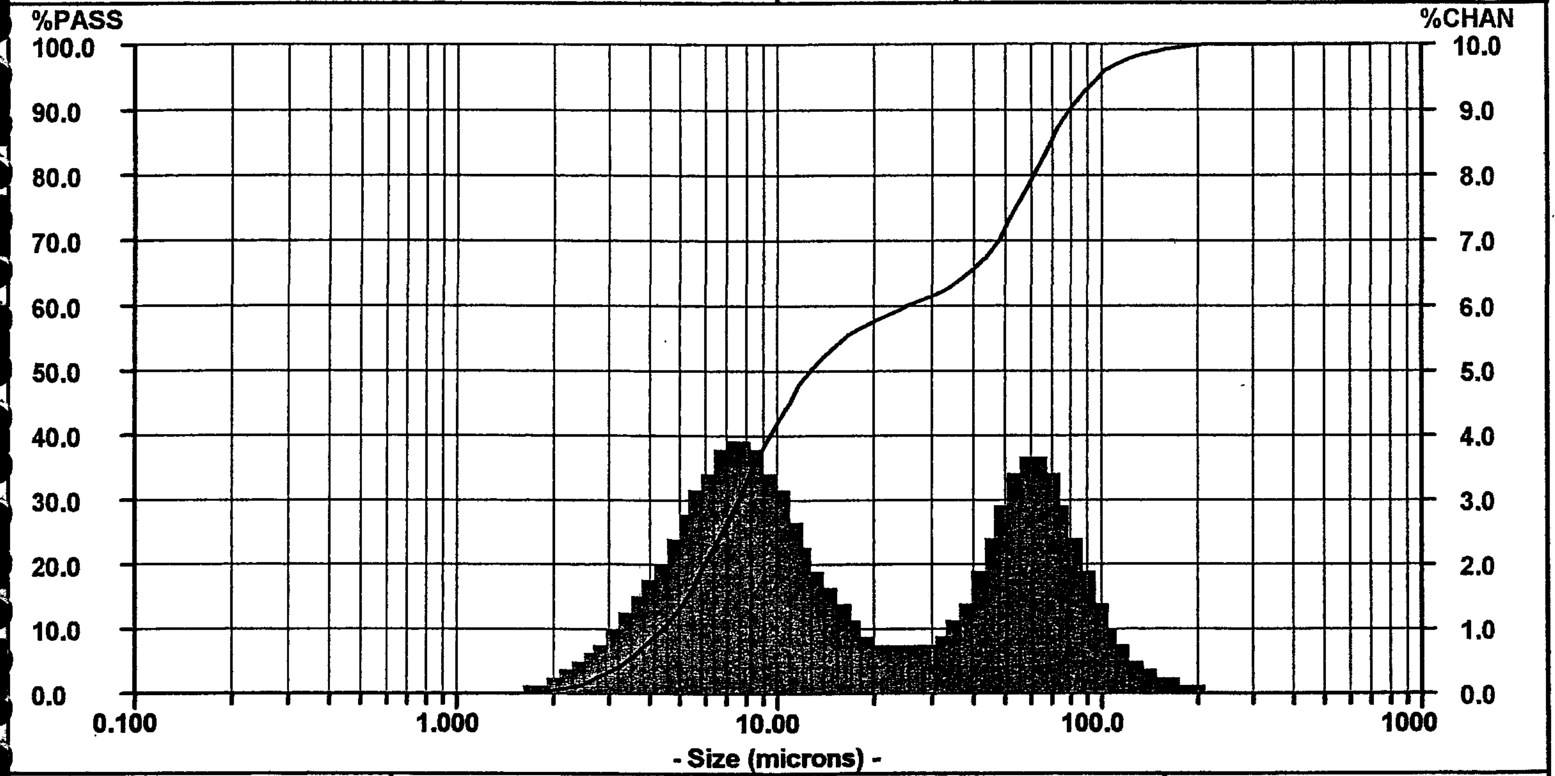
Ver:7.02

Carmeuse Tech Center	06-0249 U1E-P	Date: 04/18/06 Meas #: 198 Time: 16:30 Pres #: 1

Codan Associates (5254 mgp)
Project: 5004
U1E-P

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 32.38	10% = 4.442	60% = 25.37	61.12	41%	51.17
mn = 3.708	20% = 6.087	70% = 47.99	7.542	59%	8.191
ma = 10.08	30% = 7.649	80% = 62.05			
cs = 0.595	40% = 9.569	90% = 80.22			
sd = 31.36	50% = 12.85	95% = 98.50			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	90.20	2.95	9.250	38.59	3.83	1.060	0.00	0.00
645.6	100.00	0.00	74.00	87.25	3.43	8.482	34.76	3.98	0.972	0.00	0.00
592.0	100.00	0.00	67.86	83.82	3.69	7.778	30.78	3.98	0.892	0.00	0.00
542.9	100.00	0.00	62.23	80.13	3.69	7.133	26.80	3.84	0.818	0.00	0.00
497.8	100.00	0.00	57.06	76.44	3.46	6.541	22.96	3.54	0.750	0.00	0.00
456.5	100.00	0.00	52.33	72.98	2.98	5.998	19.42	3.19	0.688	0.00	0.00
418.6	100.00	0.00	47.98	70.00	2.48	5.500	16.23	2.79	0.630	0.00	0.00
383.9	100.00	0.00	44.00	67.52	1.94	5.044	13.44	2.43	0.578	0.00	0.00
352.0	100.00	0.00	40.35	65.58	1.51	4.625	11.01	2.09	0.530	0.00	0.00
322.8	100.00	0.00	37.00	64.07	1.20	4.241	8.92	1.79	0.486	0.00	0.00
296.0	100.00	0.00	33.93	62.87	0.98	3.889	7.13	1.54	0.446	0.00	0.00
271.4	100.00	0.00	31.11	61.89	0.84	3.566	5.59	1.30	0.409	0.00	0.00
248.9	100.00	0.00	28.53	61.05	0.78	3.270	4.29	1.09	0.375	0.00	0.00
228.2	100.00	0.00	26.16	60.27	0.77	2.999	3.20	0.88	0.344	0.00	0.00
209.3	100.00	0.16	23.99	59.50	0.80	2.750	2.32	0.69	0.315	0.00	0.00
191.9	99.84	0.25	22.00	58.70	0.88	2.522	1.63	0.54	0.289	0.00	0.00
176.0	99.59	0.28	20.17	57.82	1.01	2.312	1.09	0.40	0.265	0.00	0.00
161.4	99.31	0.35	18.50	56.81	1.19	2.121	0.69	0.30	0.243	0.00	0.00
148.0	98.96	0.46	16.96	55.62	1.42	1.945	0.39	0.24	0.223	0.00	0.00
135.7	98.50	0.61	15.56	54.20	1.70	1.783	0.15	0.15	0.204	0.00	0.00
124.5	97.89	0.81	14.27	52.50	2.02	1.635	0.00	0.00	0.187	0.00	0.00
114.1	97.08	1.09	13.08	50.48	2.39	1.499	0.00	0.00	0.172	0.00	0.00
104.7	95.99	1.46	12.00	48.09	2.78	1.375	0.00	0.00	0.158	0.00	0.00
95.96	94.53	1.90	11.00	45.31	3.18	1.261	0.00	0.00	0.145	0.00	0.00
88.00	92.63	2.43	10.09	42.13	3.54	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1511
Transmission: 0.89
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

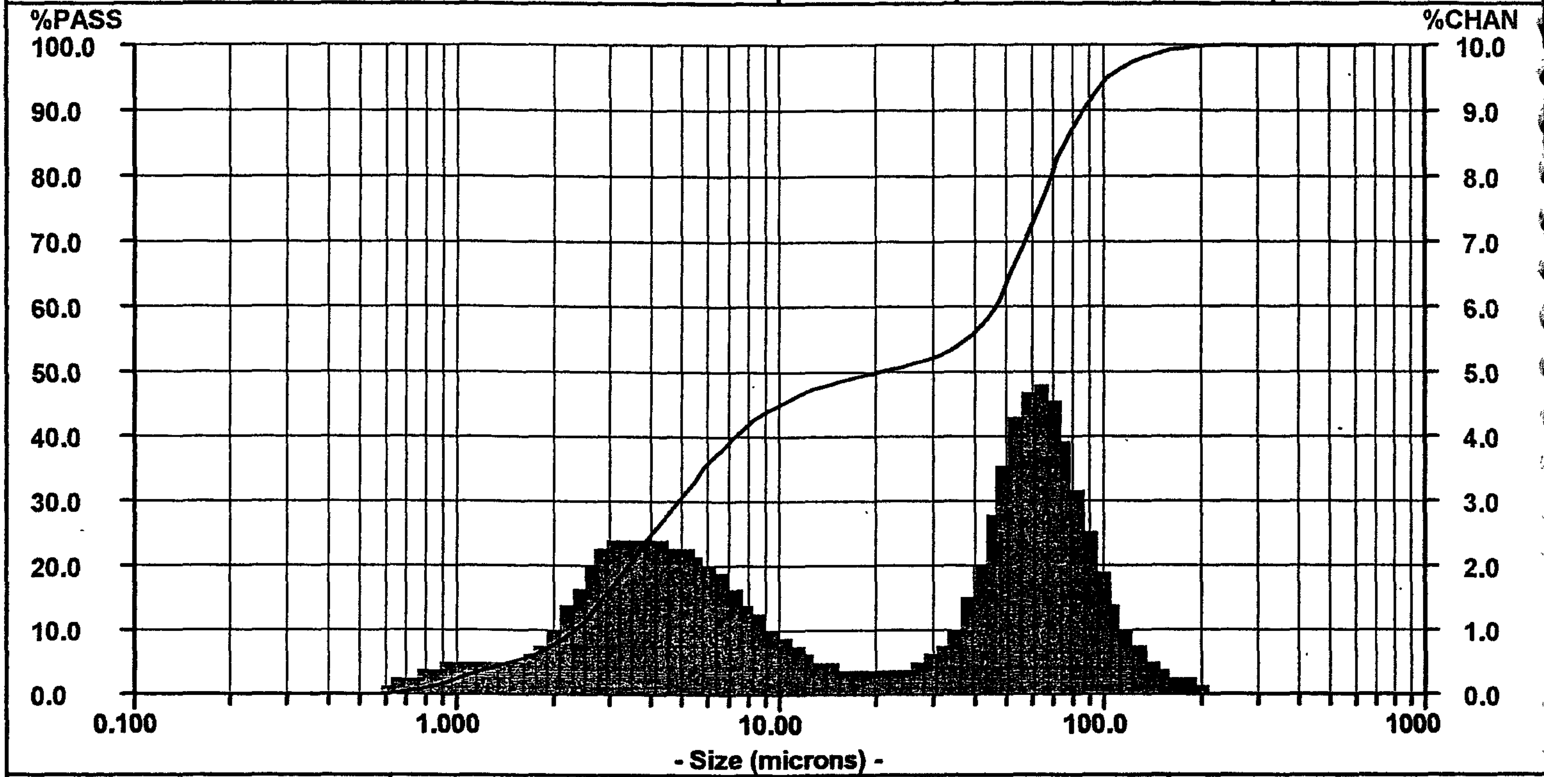
Ver:7.02

Carmeuse Tech Center	06-0250 U2A-O	Date: 04/19/06 Meas #: 199 Time: 09:58 Pres #: 1

Codan Associates (5255 mgp)
Project: 5004
U2A-O

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 36.92	10% = 2.335	60% = 46.63	63.34	50%	48.99
mn = 1.141	20% = 3.457	70% = 58.12	4.333	46%	5.799
ma = 5.779	30% = 4.912	80% = 69.57	0.888	4%	0.364
cs = 1.038	40% = 7.338	90% = 86.82			
sd = 36.09	50% = 20.26	95% = 104.7			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	87.21	3.96	9.250	43.97	1.30	1.060	2.88	0.57
645.6	100.00	0.00	74.00	83.25	4.59	8.482	42.67	1.51	0.972	2.31	0.55
592.0	100.00	0.00	67.86	78.66	4.87	7.778	41.16	1.75	0.892	1.76	0.50
542.9	100.00	0.00	62.23	73.79	4.78	7.133	39.41	1.95	0.818	1.26	0.42
497.8	100.00	0.00	57.06	69.01	4.37	6.541	37.46	2.13	0.750	0.84	0.35
456.5	100.00	0.00	52.33	64.64	3.62	5.998	35.33	2.26	0.688	0.49	0.30
418.6	100.00	0.00	47.98	61.02	2.88	5.500	33.07	2.34	0.630	0.19	0.19
383.9	100.00	0.00	44.00	58.14	2.12	5.044	30.73	2.39	0.578	0.00	0.00
352.0	100.00	0.00	40.35	56.02	1.55	4.625	28.34	2.43	0.530	0.00	0.00
322.8	100.00	0.00	37.00	54.47	1.13	4.241	25.91	2.48	0.486	0.00	0.00
296.0	100.00	0.00	33.93	53.34	0.84	3.889	23.43	2.52	0.446	0.00	0.00
271.4	100.00	0.00	31.11	52.50	0.65	3.566	20.91	2.51	0.409	0.00	0.00
248.9	100.00	0.00	28.53	51.85	0.54	3.270	18.40	2.47	0.375	0.00	0.00
228.2	100.00	0.00	26.16	51.31	0.47	2.999	15.93	2.31	0.344	0.00	0.00
209.3	100.00	0.17	23.99	50.84	0.44	2.750	13.62	2.06	0.315	0.00	0.00
191.9	99.83	0.26	22.00	50.40	0.42	2.522	11.56	1.75	0.289	0.00	0.00
176.0	99.57	0.32	20.17	49.98	0.43	2.312	9.81	1.40	0.265	0.00	0.00
161.4	99.25	0.41	18.50	49.55	0.45	2.121	8.41	1.10	0.243	0.00	0.00
148.0	98.84	0.57	16.96	49.10	0.49	1.945	7.31	0.87	0.223	0.00	0.00
135.7	98.27	0.77	15.56	48.61	0.54	1.783	6.44	0.70	0.204	0.00	0.00
124.5	97.50	1.06	14.27	48.07	0.60	1.635	5.74	0.61	0.187	0.00	0.00
114.1	96.44	1.44	13.08	47.47	0.69	1.499	5.13	0.56	0.172	0.00	0.00
104.7	95.00	1.95	12.00	46.78	0.79	1.375	4.57	0.55	0.158	0.00	0.00
95.96	93.05	2.56	11.00	45.99	0.93	1.261	4.02	0.56	0.145	0.00	0.00
88.00	90.49	3.28	10.09	45.06	1.09	1.156	3.46	0.58	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1216
Transmission: 0.89
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

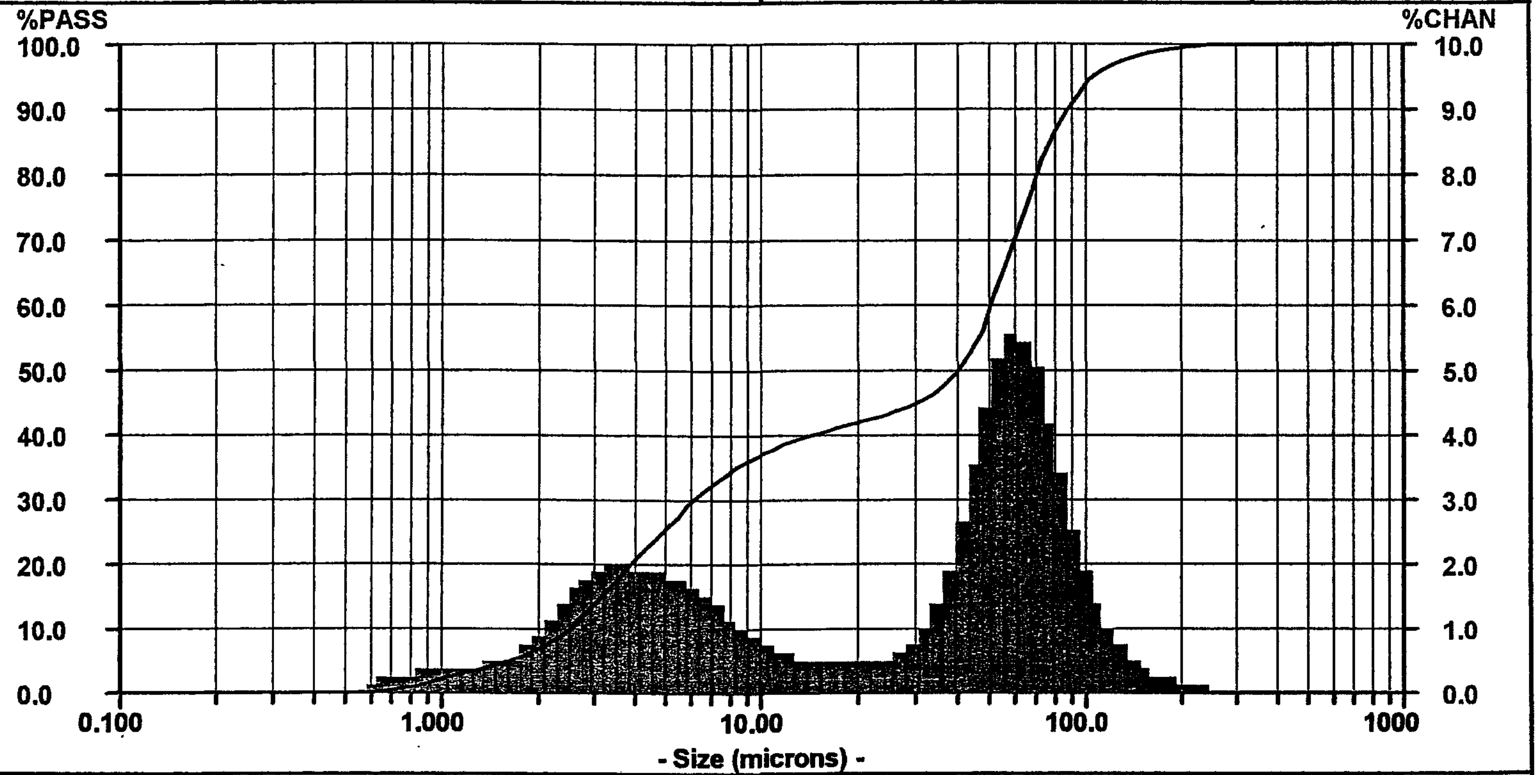
Ver:7.02

Carmeuse Tech Center	06-0251 U2A-P	Date: 04/19/06 Meas #: 205 Time: 10:21 Pres #: 1

Codan Associates (5256 mgp)
Project: 5004
U2A-P

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 41.39	10% = 2.510	60% = 51.68	61.45	58%	47.97
mn = 1.123	20% = 3.940	70% = 60.74	4.352	38%	6.245
ma = 6.683	30% = 6.230	80% = 71.11	0.885	4%	0.368
cs = 0.898	40% = 14.47	90% = 88.03			
sd = 36.61	50% = 40.60	95% = 107.2			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	86.54	4.27	9.250	36.20	1.07	1.060	2.54	0.50
645.6	100.00	0.00	74.00	82.27	5.11	8.482	35.13	1.23	0.972	2.04	0.48
592.0	100.00	0.00	67.86	77.16	5.56	7.778	33.90	1.40	0.892	1.56	0.43
542.9	100.00	0.00	62.23	71.60	5.63	7.133	32.50	1.56	0.818	1.13	0.37
497.8	100.00	0.00	57.06	65.97	5.28	6.541	30.94	1.69	0.750	0.76	0.31
456.5	100.00	0.00	52.33	60.69	4.50	5.998	29.25	1.80	0.688	0.45	0.27
418.6	100.00	0.00	47.98	56.19	3.64	5.500	27.45	1.87	0.630	0.18	0.18
383.9	100.00	0.00	44.00	52.55	2.72	5.044	25.58	1.92	0.578	0.00	0.00
352.0	100.00	0.00	40.35	49.83	2.01	4.625	23.66	1.96	0.530	0.00	0.00
322.8	100.00	0.00	37.00	47.82	1.47	4.241	21.70	2.00	0.486	0.00	0.00
296.0	100.00	0.00	33.93	46.35	1.10	3.889	19.70	2.03	0.446	0.00	0.00
271.4	100.00	0.00	31.11	45.25	0.85	3.566	17.67	2.03	0.409	0.00	0.00
248.9	100.00	0.13	28.53	44.40	0.70	3.270	15.64	1.99	0.375	0.00	0.00
228.2	99.87	0.20	26.16	43.70	0.60	2.999	13.65	1.88	0.344	0.00	0.00
209.3	99.67	0.22	23.99	43.10	0.55	2.750	11.77	1.69	0.315	0.00	0.00
191.9	99.45	0.26	22.00	42.55	0.52	2.522	10.08	1.45	0.289	0.00	0.00
176.0	99.19	0.34	20.17	42.03	0.51	2.312	8.63	1.18	0.265	0.00	0.00
161.4	98.85	0.43	18.50	41.52	0.52	2.121	7.45	0.96	0.243	0.00	0.00
148.0	98.42	0.58	16.96	41.00	0.53	1.945	6.49	0.77	0.223	0.00	0.00
135.7	97.84	0.77	15.56	40.47	0.56	1.783	5.72	0.63	0.204	0.00	0.00
124.5	97.07	1.05	14.27	39.91	0.60	1.635	5.09	0.55	0.187	0.00	0.00
114.1	96.02	1.44	13.08	39.31	0.65	1.499	4.54	0.51	0.172	0.00	0.00
104.7	94.58	1.96	12.00	38.66	0.72	1.375	4.03	0.50	0.158	0.00	0.00
95.96	92.62	2.63	11.00	37.94	0.81	1.261	3.53	0.49	0.145	0.00	0.00
88.00	89.99	3.45	10.09	37.13	0.93	1.156	3.04	0.50	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1777
Transmission: 0.86
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

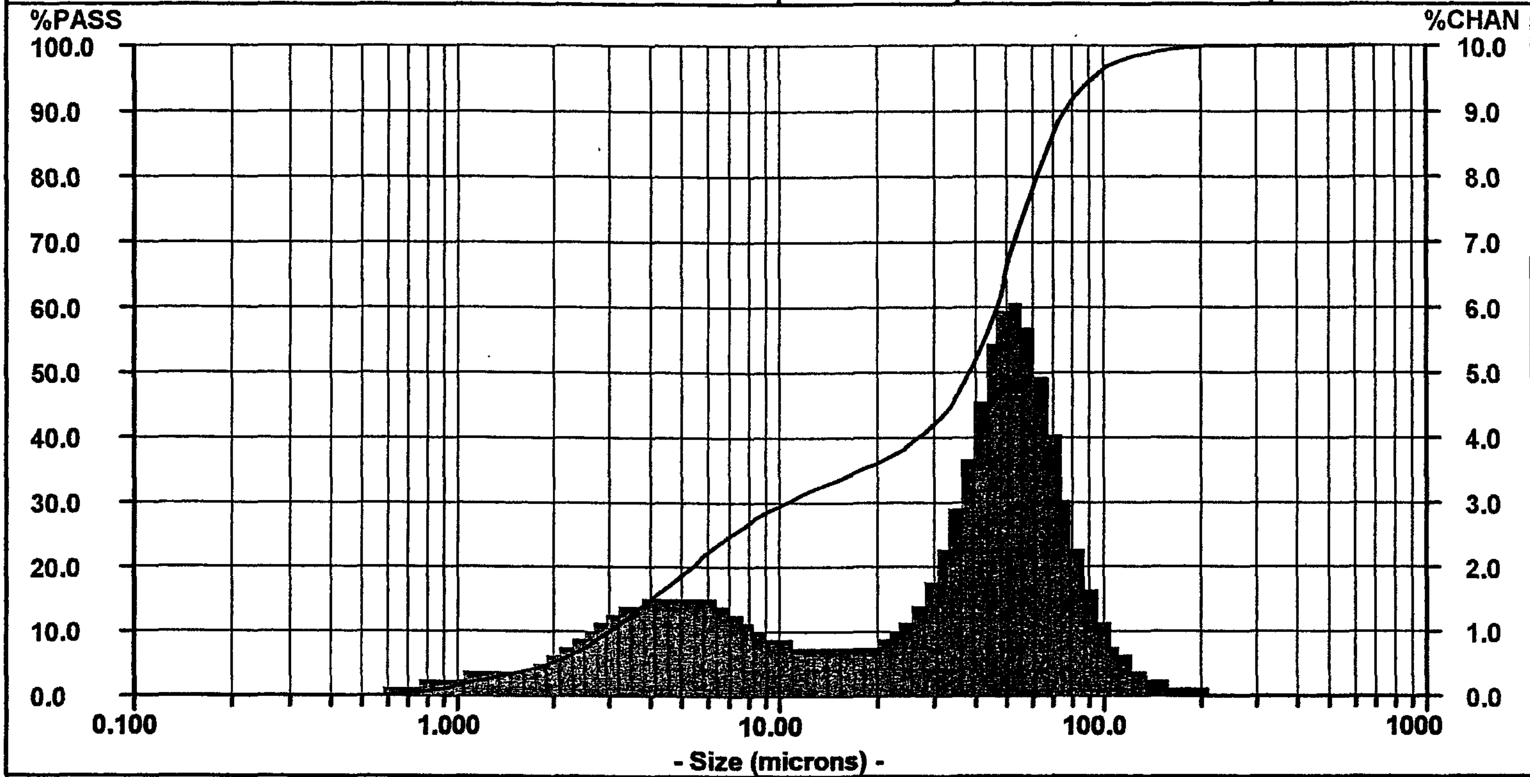
Ver:7.0

Carmeuse Tech Center	06-0252 U2C-O	Date: 04/19/06 Meas #: 213 Time: 11:15 Pres #: 1

Codan Associates (5257 mgp)
Project: 5004
U2C-O

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 38.79	10% = 3.029	60% = 46.72	51.11	68%	43.56
mn = 1.109	20% = 5.393	70% = 54.04	4.355	32%	6.180
ma = 8.210	30% = 10.46	80% = 62.71			
cs = 0.731	40% = 27.21	90% = 76.86			
sd = 31.46	50% = 38.95	95% = 92.59			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	91.65	3.10	9.250	28.63	1.09	1.060	1.96	0.37
645.6	100.00	0.00	74.00	88.55	4.06	8.482	27.54	1.22	0.972	1.59	0.35
592.0	100.00	0.00	67.86	84.49	4.94	7.778	26.32	1.35	0.892	1.24	0.33
542.9	100.00	0.00	62.23	79.55	5.73	7.133	24.97	1.46	0.818	0.91	0.28
497.8	100.00	0.00	57.06	73.82	6.08	6.541	23.51	1.55	0.750	0.63	0.25
456.5	100.00	0.00	52.33	67.74	5.98	5.998	21.96	1.59	0.688	0.38	0.23
418.6	100.00	0.00	47.98	61.76	5.50	5.500	20.37	1.61	0.630	0.15	0.15
383.9	100.00	0.00	44.00	56.26	4.62	5.044	18.76	1.59	0.578	0.00	0.00
352.0	100.00	0.00	40.35	51.64	3.78	4.625	17.17	1.56	0.530	0.00	0.00
322.8	100.00	0.00	37.00	47.86	2.95	4.241	15.61	1.52	0.486	0.00	0.00
296.0	100.00	0.00	33.93	44.91	2.29	3.889	14.09	1.47	0.446	0.00	0.00
271.4	100.00	0.00	31.11	42.62	1.80	3.566	12.62	1.42	0.409	0.00	0.00
248.9	100.00	0.00	28.53	40.82	1.44	3.270	11.20	1.35	0.375	0.00	0.00
228.2	100.00	0.00	26.16	39.38	1.21	2.999	9.85	1.25	0.344	0.00	0.00
209.3	100.00	0.13	23.99	38.17	1.04	2.750	8.60	1.12	0.315	0.00	0.00
191.9	99.87	0.19	22.00	37.13	0.94	2.522	7.48	0.98	0.289	0.00	0.00
176.0	99.68	0.22	20.17	36.19	0.86	2.312	6.50	0.82	0.265	0.00	0.00
161.4	99.46	0.27	18.50	35.33	0.82	2.121	5.68	0.69	0.243	0.00	0.00
148.0	99.19	0.36	16.96	34.51	0.79	1.945	4.99	0.57	0.223	0.00	0.00
135.7	98.83	0.47	15.56	33.72	0.78	1.783	4.42	0.49	0.204	0.00	0.00
124.5	98.36	0.64	14.27	32.94	0.78	1.635	3.93	0.43	0.187	0.00	0.00
114.1	97.72	0.87	13.08	32.16	0.80	1.499	3.50	0.40	0.172	0.00	0.00
104.7	96.85	1.21	12.00	31.36	0.84	1.375	3.10	0.38	0.158	0.00	0.00
95.96	95.64	1.68	11.00	30.52	0.90	1.261	2.72	0.38	0.145	0.00	0.00
88.00	93.96	2.31	10.09	29.62	0.99	1.156	2.34	0.38	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1229
Transmission: 0.91
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

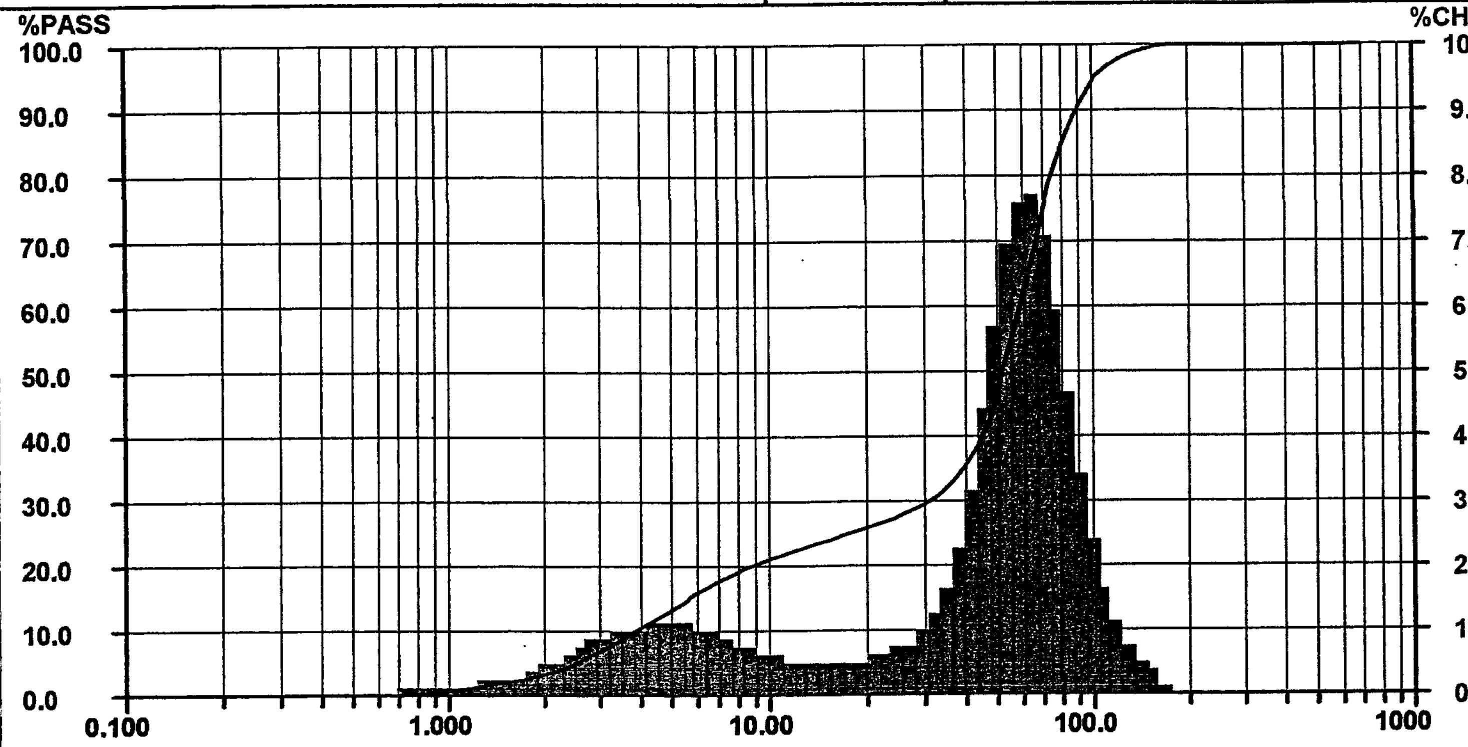
Ver:7.02

Carmeuse Tech Center	06-0253 U2C-P	Date: 04/19/06 Meas #: 225 Time: 14:08 Pres #: 1

Codan Associates (5258 mgp)
Project: 5004
U2C-P

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 49.78	10% = 3.907	60% = 59.82	60.83	77%	45.21
mn = 1.331	20% = 8.788	70% = 66.88	4.380	23%	6.030
ma = 11.62	30% = 31.13	80% = 75.57			
cs = 0.516	40% = 45.26	90% = 89.65			
sd = 37.00	50% = 53.11	95% = 104.0			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	84.47	5.97	9.250	20.45	0.77	1.060	0.98	0.23
645.6	100.00	0.00	74.00	78.50	7.19	8.482	19.68	0.86	0.972	0.75	0.22
592.0	100.00	0.00	67.86	71.31	7.76	7.778	18.82	0.96	0.892	0.53	0.20
542.9	100.00	0.00	62.23	63.55	7.69	7.133	17.86	1.04	0.818	0.33	0.20
497.8	100.00	0.00	57.06	55.86	7.00	6.541	16.82	1.11	0.750	0.13	0.13
456.5	100.00	0.00	52.33	48.86	5.73	5.998	15.71	1.16	0.688	0.00	0.00
418.6	100.00	0.00	47.98	43.13	4.48	5.500	14.55	1.17	0.630	0.00	0.00
383.9	100.00	0.00	44.00	38.65	3.26	5.044	13.38	1.17	0.578	0.00	0.00
352.0	100.00	0.00	40.35	35.39	2.36	4.625	12.21	1.15	0.530	0.00	0.00
322.8	100.00	0.00	37.00	33.03	1.74	4.241	11.06	1.12	0.486	0.00	0.00
296.0	100.00	0.00	33.93	31.29	1.30	3.889	9.94	1.10	0.446	0.00	0.00
271.4	100.00	0.00	31.11	29.99	1.03	3.566	8.84	1.05	0.409	0.00	0.00
248.9	100.00	0.00	28.53	28.96	0.86	3.270	7.79	1.00	0.375	0.00	0.00
228.2	100.00	0.00	26.16	28.10	0.76	2.999	6.79	0.93	0.344	0.00	0.00
209.3	100.00	0.00	23.99	27.34	0.70	2.750	5.86	0.84	0.315	0.00	0.00
191.9	100.00	0.00	22.00	26.64	0.66	2.522	5.02	0.73	0.289	0.00	0.00
176.0	100.00	0.21	20.17	25.98	0.63	2.312	4.29	0.62	0.265	0.00	0.00
161.4	99.79	0.38	18.50	25.35	0.62	2.121	3.67	0.52	0.243	0.00	0.00
148.0	99.41	0.53	16.96	24.73	0.60	1.945	3.15	0.43	0.223	0.00	0.00
135.7	98.88	0.79	15.56	24.13	0.58	1.783	2.72	0.37	0.204	0.00	0.00
124.5	98.09	1.17	14.27	23.55	0.58	1.635	2.35	0.32	0.187	0.00	0.00
114.1	96.92	1.73	13.08	22.97	0.58	1.499	2.03	0.28	0.172	0.00	0.00
104.7	95.19	2.50	12.00	22.39	0.60	1.375	1.75	0.27	0.158	0.00	0.00
95.96	92.69	3.49	11.00	21.79	0.64	1.261	1.48	0.25	0.145	0.00	0.00
88.00	89.20	4.73	10.09	21.15	0.70	1.156	1.23	0.25	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.1424
Transmission: 0.91
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

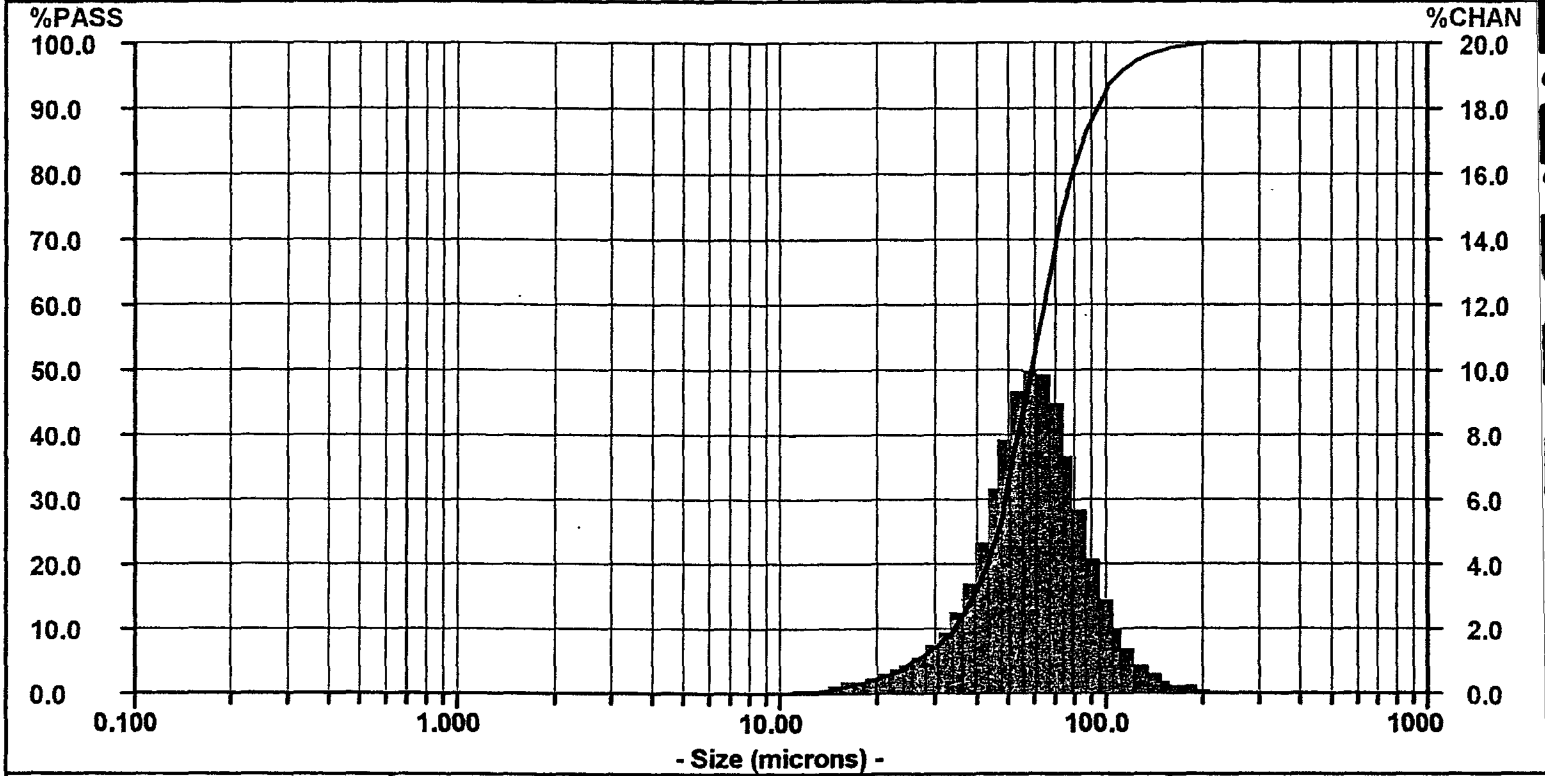
Ver:7.0

Carmeuse Tech Center	06-0254 U2D-O	Date: 04/19/06 Meas #: 224 Time: 13:28 Pres #: 1

Codan Associates (5259 mgp)
Project: 5004
U2D-O

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 63.18	10% = 34.32	60% = 65.28	59.90	100%	44.01
mn = 29.90	20% = 43.54	70% = 71.54			
ma = 52.48	30% = 49.65	80% = 79.94			
cs = 0.114	40% = 54.87	90% = 94.39			
sd = 22.00	50% = 59.90	95% = 110.1			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	80.78	7.37	9.250	0.00	0.00	1.060	0.00	0.00
645.6	100.00	0.00	74.00	73.41	9.02	8.482	0.00	0.00	0.972	0.00	0.00
592.0	100.00	0.00	67.86	64.39	9.93	7.778	0.00	0.00	0.892	0.00	0.00
542.9	100.00	0.00	62.23	54.46	10.07	7.133	0.00	0.00	0.818	0.00	0.00
497.8	100.00	0.00	57.06	44.39	9.41	6.541	0.00	0.00	0.750	0.00	0.00
456.5	100.00	0.00	52.33	34.98	7.94	5.998	0.00	0.00	0.688	0.00	0.00
418.6	100.00	0.00	47.98	27.04	6.40	5.500	0.00	0.00	0.630	0.00	0.00
383.9	100.00	0.00	44.00	20.64	4.79	5.044	0.00	0.00	0.578	0.00	0.00
352.0	100.00	0.00	40.35	15.85	3.54	4.625	0.00	0.00	0.530	0.00	0.00
322.8	100.00	0.00	37.00	12.31	2.63	4.241	0.00	0.00	0.486	0.00	0.00
296.0	100.00	0.00	33.93	9.68	1.97	3.889	0.00	0.00	0.446	0.00	0.00
271.4	100.00	0.00	31.11	7.71	1.54	3.566	0.00	0.00	0.409	0.00	0.00
248.9	100.00	0.00	28.53	6.17	1.22	3.270	0.00	0.00	0.375	0.00	0.00
228.2	100.00	0.00	26.16	4.95	1.01	2.999	0.00	0.00	0.344	0.00	0.00
209.3	100.00	0.16	23.99	3.94	0.85	2.750	0.00	0.00	0.315	0.00	0.00
191.9	99.84	0.26	22.00	3.09	0.71	2.522	0.00	0.00	0.289	0.00	0.00
176.0	99.58	0.33	20.17	2.38	0.59	2.312	0.00	0.00	0.265	0.00	0.00
161.4	99.25	0.46	18.50	1.79	0.48	2.121	0.00	0.00	0.243	0.00	0.00
148.0	98.79	0.66	16.96	1.31	0.39	1.945	0.00	0.00	0.223	0.00	0.00
135.7	98.13	0.96	15.56	0.92	0.31	1.783	0.00	0.00	0.204	0.00	0.00
124.5	97.17	1.40	14.27	0.61	0.25	1.635	0.00	0.00	0.187	0.00	0.00
114.1	95.77	2.05	13.08	0.36	0.22	1.499	0.00	0.00	0.172	0.00	0.00
104.7	93.72	2.98	12.00	0.14	0.14	1.375	0.00	0.00	0.158	0.00	0.00
95.96	90.74	4.20	11.00	0.00	0.00	1.261	0.00	0.00	0.145	0.00	0.00
88.00	86.54	5.76	10.09	0.00	0.00	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.0908
Transmission: 0.95
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

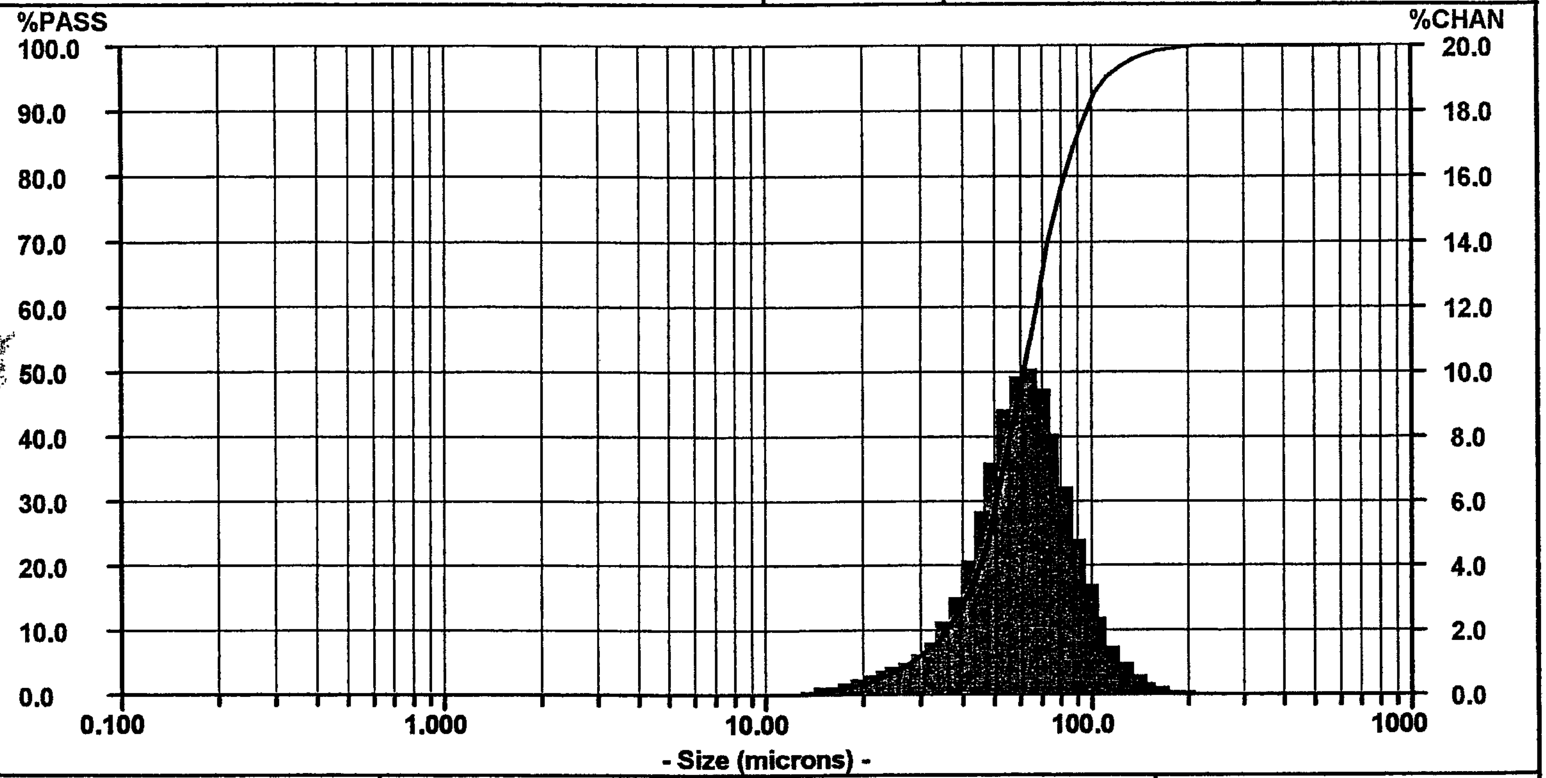
Ver:7.02

Carmeuse Tech Center	06-0255 U2D-P	Date: 04/19/06 Meas #: 222 Time: 13:15 Pres #: 1

Codan Associates (5260 mgp)
Project: 5004
U2D-P

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 65.46	10% = 36.16	60% = 67.77	62.26	100%	45.04
mn = 33.71	20% = 45.44	70% = 74.18			
ma = 55.09	30% = 51.72	80% = 82.82			
cs = 0.109	40% = 57.06	90% = 97.30			
sd = 22.52	50% = 62.26	95% = 112.7			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	77.93	8.16	9.250	0.00	0.00	1.060	0.00	0.00
645.6	100.00	0.00	74.00	69.77	9.62	8.482	0.00	0.00	0.972	0.00	0.00
592.0	100.00	0.00	67.86	60.15	10.21	7.778	0.00	0.00	0.892	0.00	0.00
542.9	100.00	0.00	62.23	49.94	9.93	7.133	0.00	0.00	0.818	0.00	0.00
497.8	100.00	0.00	57.06	40.01	8.96	6.541	0.00	0.00	0.750	0.00	0.00
456.5	100.00	0.00	52.33	31.05	7.30	5.998	0.00	0.00	0.688	0.00	0.00
418.6	100.00	0.00	47.98	23.75	5.73	5.500	0.00	0.00	0.630	0.00	0.00
383.9	100.00	0.00	44.00	18.02	4.24	5.044	0.00	0.00	0.578	0.00	0.00
352.0	100.00	0.00	40.35	13.78	3.11	4.625	0.00	0.00	0.530	0.00	0.00
322.8	100.00	0.00	37.00	10.67	2.32	4.241	0.00	0.00	0.486	0.00	0.00
296.0	100.00	0.00	33.93	8.35	1.76	3.889	0.00	0.00	0.446	0.00	0.00
271.4	100.00	0.00	31.11	6.59	1.38	3.566	0.00	0.00	0.409	0.00	0.00
248.9	100.00	0.00	28.53	5.21	1.12	3.270	0.00	0.00	0.375	0.00	0.00
228.2	100.00	0.00	26.16	4.09	0.93	2.999	0.00	0.00	0.344	0.00	0.00
209.3	100.00	0.15	23.99	3.16	0.77	2.750	0.00	0.00	0.315	0.00	0.00
191.9	99.85	0.25	22.00	2.39	0.64	2.522	0.00	0.00	0.289	0.00	0.00
176.0	99.60	0.33	20.17	1.75	0.53	2.312	0.00	0.00	0.265	0.00	0.00
161.4	99.27	0.49	18.50	1.22	0.42	2.121	0.00	0.00	0.243	0.00	0.00
148.0	98.78	0.73	16.96	0.80	0.34	1.945	0.00	0.00	0.223	0.00	0.00
135.7	98.05	1.09	15.56	0.46	0.28	1.783	0.00	0.00	0.204	0.00	0.00
124.5	96.96	1.63	14.27	0.18	0.18	1.635	0.00	0.00	0.187	0.00	0.00
114.1	95.33	2.42	13.08	0.00	0.00	1.499	0.00	0.00	0.172	0.00	0.00
104.7	92.91	3.51	12.00	0.00	0.00	1.375	0.00	0.00	0.158	0.00	0.00
95.96	89.40	4.89	11.00	0.00	0.00	1.261	0.00	0.00	0.145	0.00	0.00
88.00	84.51	6.58	10.09	0.00	0.00	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular

Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.0888
Transmission: 0.96
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

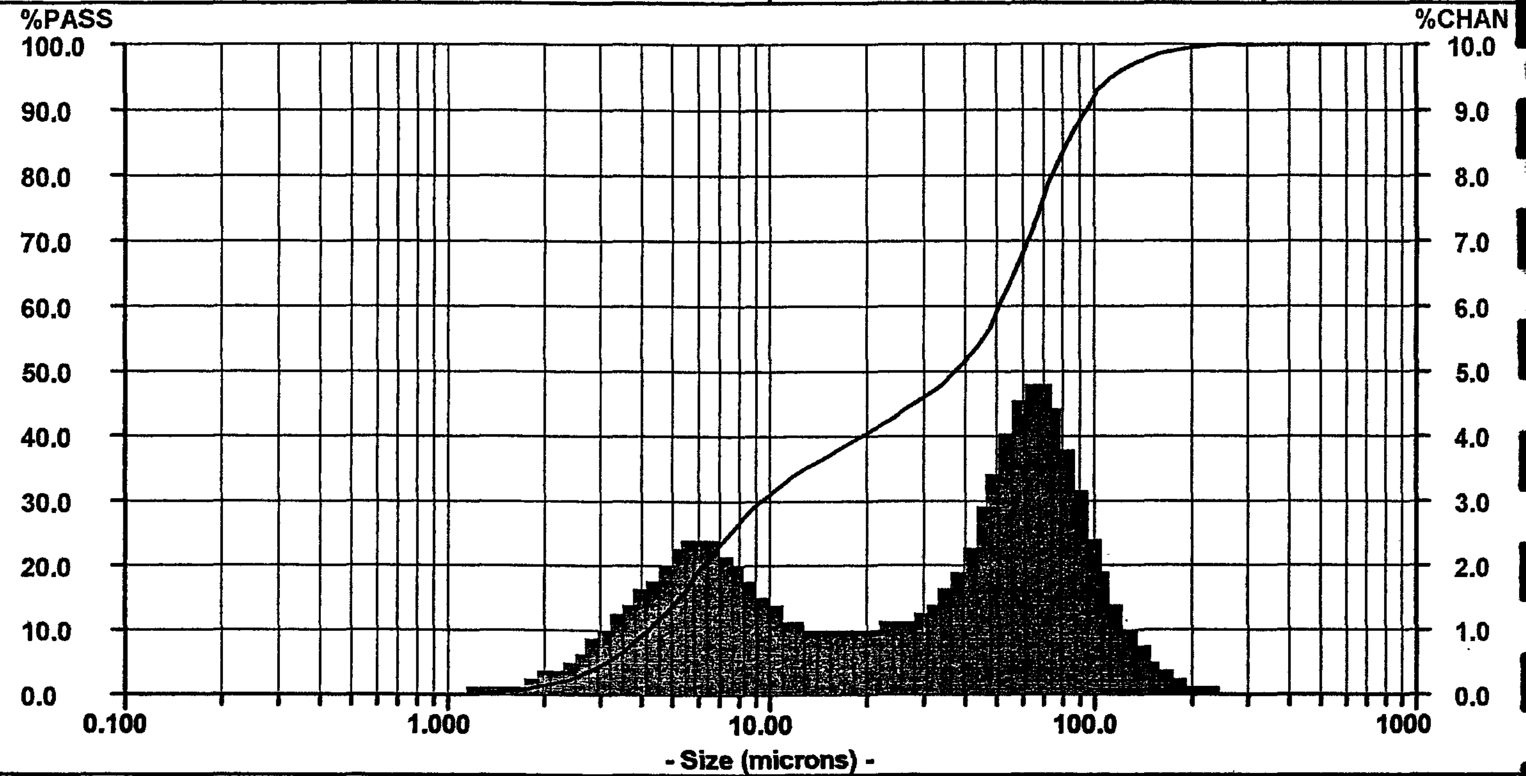
Ver:7.0

Carmeuse Tech Center	06-0256 U2F-O	Date: 04/19/06 Meas #: 228 Time: 14:30 Pres #: 1

Codan Associates (5261 mgp)
Project: 5004
U2F-O

Attn: J Wilhelm

Summary	Percentiles		Dia	Vol%	Width
mv = 43.99	10% = 4.259	60% = 51.92	61.67	63%	61.96
mn = 2.626	20% = 6.295	70% = 63.21	6.000	37%	6.737
ma = 11.40	30% = 9.419	80% = 75.55			
cs = 0.526	40% = 19.35	90% = 94.75			
sd = 38.17	50% = 37.72	95% = 115.0			



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	83.38	4.46	9.250	29.66	1.83	1.060	0.00	0.00
645.6	100.00	0.00	74.00	78.92	4.87	8.482	27.83	2.05	0.972	0.00	0.00
592.0	100.00	0.00	67.86	74.05	4.92	7.778	25.78	2.27	0.892	0.00	0.00
542.9	100.00	0.00	62.23	69.13	4.63	7.133	23.51	2.42	0.818	0.00	0.00
497.8	100.00	0.00	57.06	64.50	4.16	6.541	21.09	2.47	0.750	0.00	0.00
456.5	100.00	0.00	52.33	60.34	3.51	5.998	18.62	2.43	0.688	0.00	0.00
418.6	100.00	0.00	47.98	56.83	2.92	5.500	16.19	2.29	0.630	0.00	0.00
383.9	100.00	0.00	44.00	53.91	2.37	5.044	13.90	2.10	0.578	0.00	0.00
352.0	100.00	0.00	40.35	51.54	1.95	4.625	11.80	1.89	0.530	0.00	0.00
322.8	100.00	0.00	37.00	49.59	1.65	4.241	9.91	1.67	0.486	0.00	0.00
296.0	100.00	0.00	33.93	47.94	1.44	3.889	8.24	1.47	0.446	0.00	0.00
271.4	100.00	0.00	31.11	46.50	1.30	3.566	6.77	1.27	0.409	0.00	0.00
248.9	100.00	0.14	28.53	45.20	1.22	3.270	5.50	1.09	0.375	0.00	0.00
228.2	99.86	0.22	26.16	43.98	1.17	2.999	4.41	0.91	0.344	0.00	0.00
209.3	99.64	0.25	23.99	42.81	1.15	2.750	3.50	0.75	0.315	0.00	0.00
191.9	99.39	0.32	22.00	41.66	1.12	2.522	2.75	0.61	0.289	0.00	0.00
176.0	99.07	0.42	20.17	40.54	1.11	2.312	2.14	0.48	0.265	0.00	0.00
161.4	98.65	0.56	18.50	39.43	1.09	2.121	1.66	0.38	0.243	0.00	0.00
148.0	98.09	0.76	16.96	38.34	1.08	1.945	1.28	0.30	0.223	0.00	0.00
135.7	97.33	1.05	15.56	37.26	1.08	1.783	0.98	0.25	0.204	0.00	0.00
124.5	96.28	1.42	14.27	36.18	1.10	1.635	0.73	0.21	0.187	0.00	0.00
114.1	94.86	1.90	13.08	35.08	1.16	1.499	0.52	0.19	0.172	0.00	0.00
104.7	92.96	2.51	12.00	33.92	1.26	1.375	0.33	0.19	0.158	0.00	0.00
95.96	90.45	3.18	11.00	32.66	1.41	1.261	0.14	0.14	0.145	0.00	0.00
88.00	87.27	3.89	10.09	31.25	1.59	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.2365
Transmission: 0.85
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

LECOTRAC - LT100

Ver:7.02

Carmeuse Tech Center	06-0257 U2F-P	Date: 04/19/06 Meas #: 231 Time: 14:54 Pres #: 1

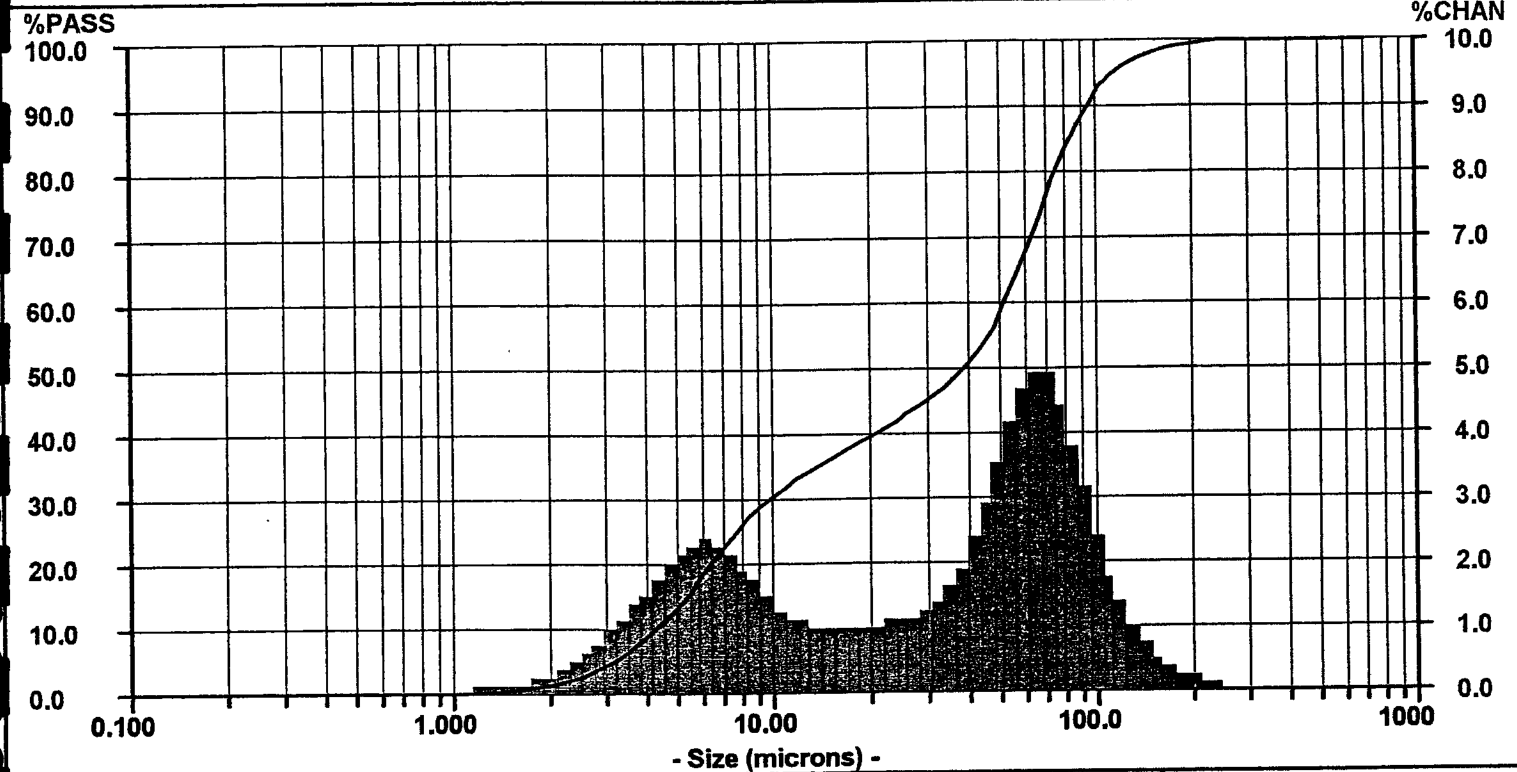
Codan Associates (5262 mgp)
Project: 5004
U2F-P

Attn: J Wilhelm

Summary	
mv =	44.46
mn =	2.636
ma =	11.65
cs =	0.515
sd =	38.14

Percentiles	
10% = 4.331	60% = 52.52
20% = 6.431	70% = 63.50
30% = 9.821	80% = 75.65
40% = 20.59	90% = 94.76
50% = 39.01	95% = 115.2

Dia	Vol%	Width
61.55	64%	61.41
6.035	36%	6.781



SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN	SIZE	%PASS	%CHAN
704.0	100.00	0.00	80.70	83.34	4.51	9.250	28.90	1.80	1.060	0.00	0.00
645.6	100.00	0.00	74.00	78.83	4.95	8.482	27.10	2.02	0.972	0.00	0.00
592.0	100.00	0.00	67.86	73.88	5.03	7.778	25.08	2.23	0.892	0.00	0.00
542.9	100.00	0.00	62.23	68.85	4.75	7.133	22.85	2.37	0.818	0.00	0.00
497.8	100.00	0.00	57.06	64.10	4.27	6.541	20.48	2.42	0.750	0.00	0.00
456.5	100.00	0.00	52.33	59.83	3.61	5.998	18.06	2.37	0.688	0.00	0.00
418.6	100.00	0.00	47.98	56.22	2.99	5.500	15.69	2.23	0.630	0.00	0.00
383.9	100.00	0.00	44.00	53.23	2.42	5.044	13.46	2.05	0.578	0.00	0.00
352.0	100.00	0.00	40.35	50.81	1.98	4.625	11.41	1.84	0.530	0.00	0.00
322.8	100.00	0.00	37.00	48.83	1.67	4.241	9.57	1.62	0.486	0.00	0.00
296.0	100.00	0.00	33.93	47.16	1.45	3.889	7.95	1.42	0.446	0.00	0.00
271.4	100.00	0.00	31.11	45.71	1.31	3.566	6.53	1.23	0.409	0.00	0.00
248.9	100.00	0.15	28.53	44.40	1.22	3.270	5.30	1.05	0.375	0.00	0.00
228.2	99.85	0.24	26.16	43.18	1.18	2.999	4.25	0.88	0.344	0.00	0.00
209.3	99.61	0.26	23.99	42.00	1.14	2.750	3.37	0.72	0.315	0.00	0.00
191.9	99.35	0.33	22.00	40.86	1.12	2.522	2.65	0.59	0.289	0.00	0.00
176.0	99.02	0.43	20.17	39.74	1.11	2.312	2.06	0.46	0.265	0.00	0.00
161.4	98.59	0.56	18.50	38.63	1.09	2.121	1.60	0.37	0.243	0.00	0.00
148.0	98.03	0.76	16.96	37.54	1.08	1.945	1.23	0.29	0.223	0.00	0.00
135.7	97.27	1.03	15.56	36.46	1.08	1.783	0.94	0.24	0.204	0.00	0.00
124.5	96.24	1.40	14.27	35.38	1.10	1.635	0.70	0.20	0.187	0.00	0.00
114.1	94.84	1.89	13.08	34.28	1.16	1.499	0.50	0.18	0.172	0.00	0.00
104.7	92.95	2.51	12.00	33.12	1.25	1.375	0.32	0.19	0.158	0.00	0.00
95.96	90.44	3.18	11.00	31.87	1.39	1.261	0.13	0.13	0.145	0.00	0.00
88.00	87.26	3.92	10.09	30.48	1.58	1.156	0.00	0.00	0.133	0.00	0.00

Distribution: Volume
Progression: Geometric Root8
Upper Edge: 704.0
Lower Edge: 0.122
Residuals: Disabled
Number Of Channels: 100
LT100 Extended Range: No
Filter On: On

RunTime: 30 seconds
Run Number 1 of 1 runs
Particle: Gypsum
Particle Transparency: Trans
Particle Refractive Index: 1.52
Particle Shape: Irregular
Database Path: C:\LT_DATA\5004.DB

Fluid: Methanol
Fluid Refractive Index: 1.33
Loading Factor: 0.2394
Transmission: 0.86
Above Residual: 0.00
Below Residual: 0.00

ASVR Flow Rate: 75
Ultrasonic Power: 20 watts
Ultrasonic Time: 60 seconds

EVALUATION OF EXISTING FILTERS AND THICKENERS
IPSC – MARCH, 2006
Based on site review and samples collected 2-1-06

THICKENERS

Feed Slurry measured 8.4 wt.% solids

Thickener overflows
'A' thickener overflow = 217 ppm suspended solids
'C' thickener overflow = 36 g/l suspended solids (3.4 wt.% solids)

Underflow slurry (filter feed tank) measured 41 to 43 wt.% solids

SETTLING TEST RESULTS (see attached thickener operating lines)

1. When the slurry from the scrubbers is split between two thickeners and when maximum 1% sulfur coal is being burned, the calculated thickener unit area is 6.6 ft2/t/d.

2. Without polymer, the settling test indicates that the underflow would reach about 42% solids. However, polymer is needed for good overflow clarity as well as to keep the coarse from separating from the fines.

3. With polymer, the settling test indicates that the underflow concentration would reach about 58% solids, which would be very difficult to rake and pump, and cannot be stored in the thickener without operating problems.

4. Both with and without polymer, the settling curves indicate that the coarse fraction of solids would reach very high underflow concentrations.

Conclusions: The existing thickeners are not well suited to handle the gypsum being produced in the scrubbers, especially if the oxidation rate varies, giving variable requirements for thickening. The amount of sludge to thicken varies with the percent sulfur in the coal, and operations must adjust to this variable amount of sludge. The thickeners can be made to work, but only if the operation is modified:

1. Eliminate solids recycle because it caused solids to overflow to ponds
2. Once the solids concentration reaches about 45 to 50 wt.% solids, the underflow slurry should be pumped to the filter feed tank.
3. The filter feed tank can store about 7,200 gallons per foot of depth.
4. Sludge production rate at 45% solids is about 16,000 gallons/hr with 1% S
5. Maximum filter feed tank capacity at 15-ft active vol. is 6.8 hours between filter cycles.

FILTERS

On 2-1-06 the sludge production rate was estimated at about 87 lb/hr/ft2, or about 30 tons/hr of sludge solids. Required filtration rate is 41 tons/hr (continuous operation) when burning 1% sulfur coal. The filtration rate was limited by the low vacuum levels, filtrate remaining in internal piping (blowback into cake), uneven cake thickness (0.25 to 0.75-inch), cloth blinding and only partial cake discharge.

Filter cake measured 77% solids and was very sloppy.

One filter would be capable of up to 50 tons/hr of sludge solids filtration if complete cake discharge were achievable and the cloth were not blinded.

Filters need to be gone over completely for mechanical checks:

1. Determine why filtrate is not being pulled out effectively to the receivers
2. Replace cloths more frequently to eliminate blinding condition (evaluate other cloths that might last longer without blinding.) Periodic cloth washing may help reduce blinding.
3. Evaluate condition of filter valve and low blowback effectiveness
4. Determine mechanical condition of vacuum pumps and capacity. Recondition if necessary.

FILTER LEAF TEST RESULTS & CONCLUSIONS

Filtration rates depend on cake solids concentration desired and whether polymer is used (see attached graphs.)

If fines are removed by a hydroseparator, both the filtration rate and the cake solids concentrations jump significantly. The quality of the cake for stacking and handling also improves dramatically.

Results indicate that with fines removed, gypsum purity will be 97 to 99%, and filter cake solids concentration will be over 90%. This material would be highly desirable for gypsum byproduct for wallboard.

With fines removed, the gypsum solids settle very rapidly and to a high concentration. The existing drum filters would have a difficult time handling these solids easily due to difficulties in suspending the solids. The drum filters can be made to work, but with cake washing required for byproduct gypsum, the filtration rate will not be good, and final cake solids concentrations will be lower.

With the use of a hydroseparator plus new horizontal belt filters, the mixing of fly ash with the gypsum filter cake can be eliminated, freeing up ash for sale and eliminating the dusting problems.

IPSC - PROCESS DESIGN OPTIONS - numbers for combined generating units
Byproduct gypsum production options

Design Basis

800 t/hr Coal combined for two generating units
1 % maximum sulfur in the coal
0.6 % average monthly sulfur in coal
0.45 % minimum sulfur in coal
0.95 fraction SO2 removed

Calculations

40.9 t/hr gypsum produced at maximum sulfur 100% load
24.5 t/hr gypsum at Average Sulfur 100% load
18.4 t/hr gypsum at Minimum Sulfur 100% load

Hydroseparator Sizing

35.0 ft. dia. Filter feed tank cutting at30 to 35 microns at max. S coal, both Units
45 - 48 wt.% solids in the underflow containing 96 to 99% gypsum
.8 to 1.8 % solids in overflow for recycle

Filter Sizing

408.5 ft2 filter for maximum sulfur coal
245.1 ft2 filter for average sulfur coal
183.8 ft2 filter for minimum sulfur coal

Thickener Siziing - scrubber blowdown

1.5 ft2/t/d gives 48% solids with 0.004 lb/ton polymer
5 ft2/t/d gives 40% solids without polymer
43 diameter thickener required with polymer at maximum Sulfur coal
79 diameter thickener required without polymer at maximum Sulfur coal

Thickener Sizing - Hydroseparator overflow

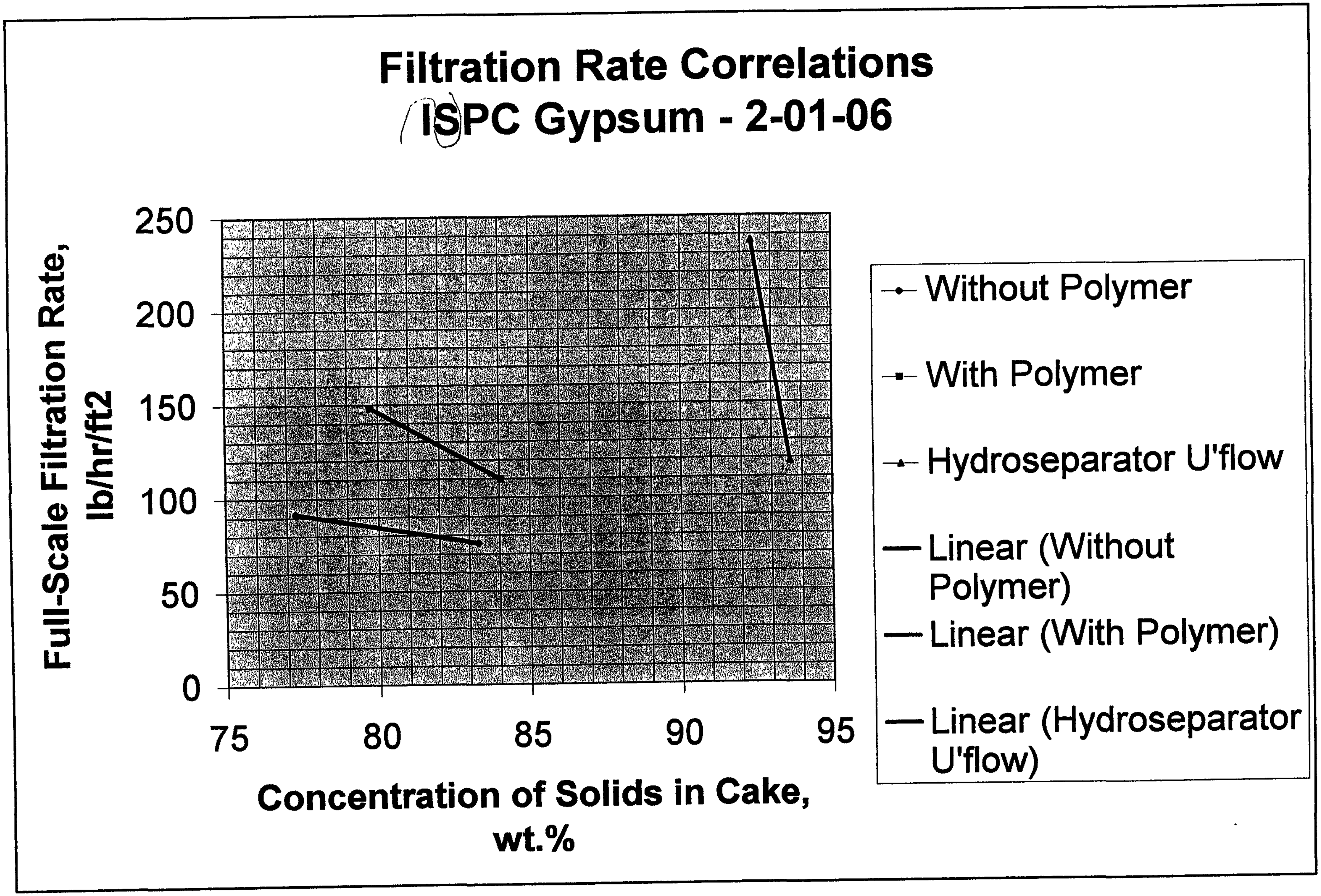
3000 gpm overflow rate for design
1.5 gpm/ft2 design rate with polymer
50 diameter thickener required (use existing 65-ft diameter thickener)
127 t/day fines to settle and recycle
30 % solids in underflow
54 gpm underflow to recycle to limestone slurry tank at maximum sulfur coal
Split between two generating units

Vacuum Filtration Leaf Tests - IPSC gypsum sludge from sample of 2-1-06

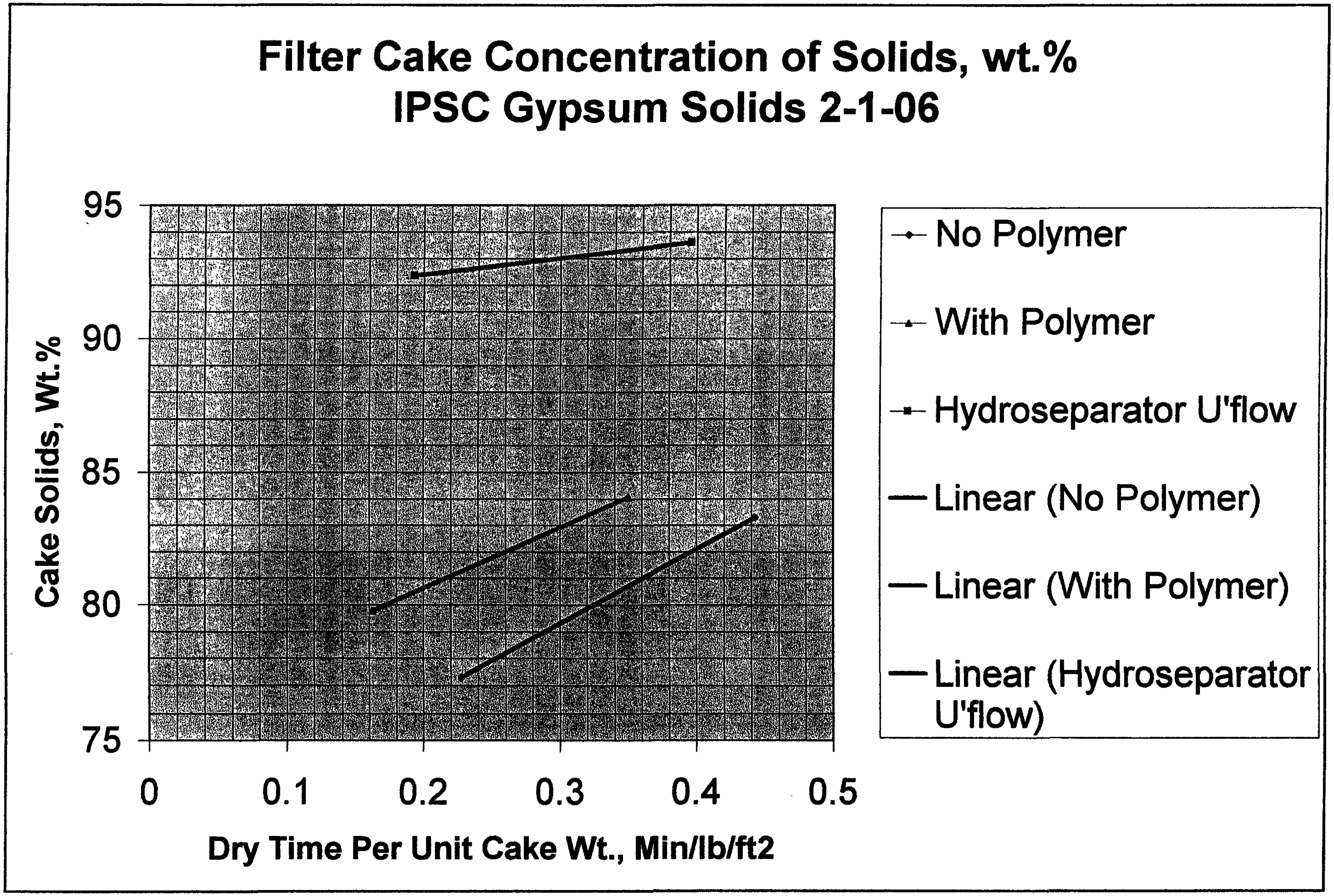
0.074 ft2 leaf with 67062 filter cloth
Air leakage = 0.17 ft3/min

Test No	Form Vac. in. Hg	Dry Vac. in. Hg	Form time seconds	Wash time seconds	Dry time seconds	Cake Cracking?	Dry Air Flow Rate ft3/min/ft2	Filtrate Volume ml	Wash Volume ml
Thickener Underflow Sample for Leaf Tests									
1	19	17	54	0	125	no	4.5	185	0
3	18	15	31	21	40	no	-	144	40
Sample from Settling Tests									
2	18	16	180	300	120	no	8.5	190	75
Flocculated Thickener Underflow									
4	17	15	15	0	60	no	-	118	0
5	18	16	45	0	45	no	-	175	0
Hydroseparator Underflow									
6	18	14	1	2	60	no	13.9	133	50
7	18	14	1	2	120	no	13.9	125	60
Fines from hydroseparator Overflow									
8	19	16	-	-		-	-	205	0

Test No.	Cake Thick. inches	Wet Weight grams	Tare Weight grams	Dry Weight grams	Cake Solids wt.%	Dry Cake Weight lb/ft2	HBF Full-Scale Rate - 0.8 SUF lb/hr/ft2	dry time per unit cake wt. min/lb/ft2	back calc. feed solids conc. wt.%
	Thickener Underflow Sample for Leaf Tests								
1	0.75	196.6	6.8	164.9	83.3	4.7	75.72	0.44	41.8
3	0.5	134	6.7	105.1	77.3	2.9	91.69	0.23	42.0
	Sample from Settling Tests								
2	1	294.5	6.7	225.4	76.0	6.5	31.25	0.31	53.8
	Flocculated Thickener Underflow								
4	0.5	121	6.8	102.8	84.1	2.9	109.73	0.35	40.9
5	0.6875	201.4	6.6	162	79.8	4.6	148.02	0.16	41.6
	Hydroseparator Underflow								
6	0.75	195	6.6	180.6	92.4	5.2	236.76	0.19	63.5
7	0.75	188.1	6.7	176.5	93.6	5.1	118.34	0.40	68.2
	Fines from hydroseparator Overflow								
8	0.625	182.9	6.6	128.6	69.2	3.6			



Filtration Rate Correlations
ISPC Gypsum - 2-01-06
Full-Scale Filtration Rate, lb/hr/ft2
250
200
150
100
50
0
75
80
85
90
95
Concentration of Solids in Cake, wt.%
Without Polymer
With Polymer
Hydroseparator U'flow
Linear (Without Polymer)
Linear (With Polymer)
Linear (Hydroseparator U'flow)


Filter Cake Concentration of Solids, wt.%
IPSC Gypsum Solids 2-1-06
Cake Solids, Wt.%
95
90
85
80
75
0
0.1
0.2
0.3
0.4
0.5
Dry Time Per Unit Cake Wt., Min/lb/ft2
No Polymer
With Polymer
Hydroseparator U'flow
Linear (No Polymer)
Linear (With Polymer)
Linear (Hydroseparator U'flow)

[redacted]

HYDROSEPARATOR

The existing filter feed tank is an ideal size to be converted to a hydroseparator to handle all of the sludge from both scrubbing units with 1% sulfur coal. (See attached hydroseparator diagram, hydroseparator material balance and particle size distributions.) Approximately 17% of the solids would be removed as fines in the hydroseparator overflow, while the remaining 83% would report as cleaned gypsum to the underflow for filtration.

The design concept would be to operate the scrubbers as at present trying to maximize oxidation while staying in compliance for SO2 removal. (See attached flow diagram.) The thickener feed tank would then send sludge to the converted filter feed tank operating as a hydroseparator. The overflow from the hydroseparator would contain the fines, which would be sent to one of the existing thickeners. The thickened fines would be pumped at a rate of 30 to 70 gpm to the limestone slurry tank, and from there distributed to all of the operating scrubbers. The gypsum would grow in the scrubbers and the residual unoxidized sulfite would be oxidized to gypsum.

Underflow from the new hydroseparator would be pumped to new horizontal belt filters. The cake would be washed, and 90% solids filter cake would be produced for byproduct gypsum. Overflow from the fines thickener would be sent to the bottom of the hydroseparator to wash the gypsum and provide the rise rate required to carry the fines out of the slurry to overflow the hydroseparator.

HYDROSEPARATOR DESIGN & MATERIAL BALANCE CALCULATIONS

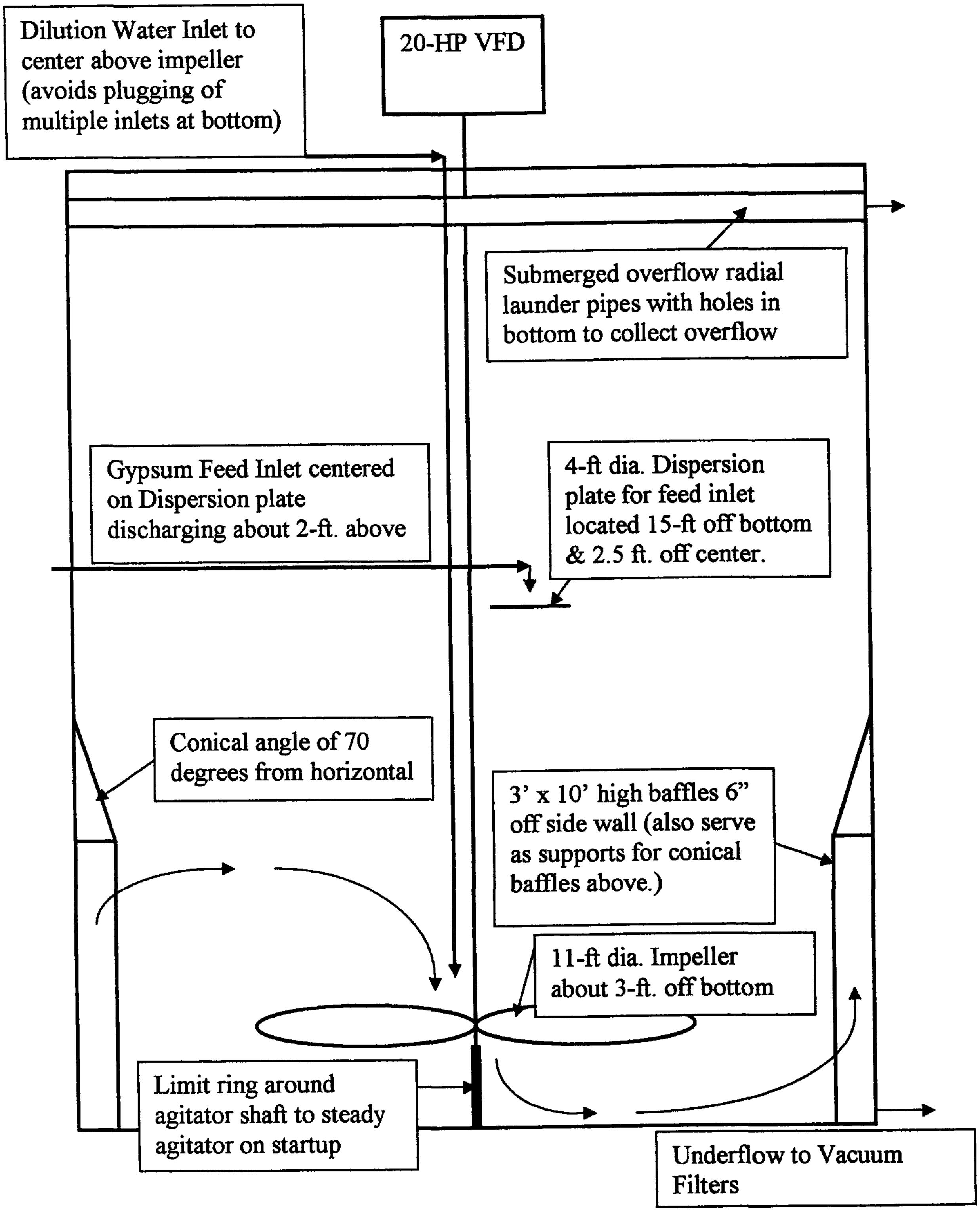
Use Filter Feed Tank at 35-ft. Diameter

(Note: Numbers In Bold Are Input Values Required For Calculations)

Stokes Law Calculations from particle size and s.g.		
Particle size, microns		35.00
Particle sp.gr.		2.32
Fluid sp.gr.		1.02
Temp, F	130.00 Viscosity, cp	0.5487208
Stoke's terminal velocity, cm/sec		0.1581218
	Ft/sec	0.0051877
	gpm/ft2	2.3282497
	in/min	3.7351599

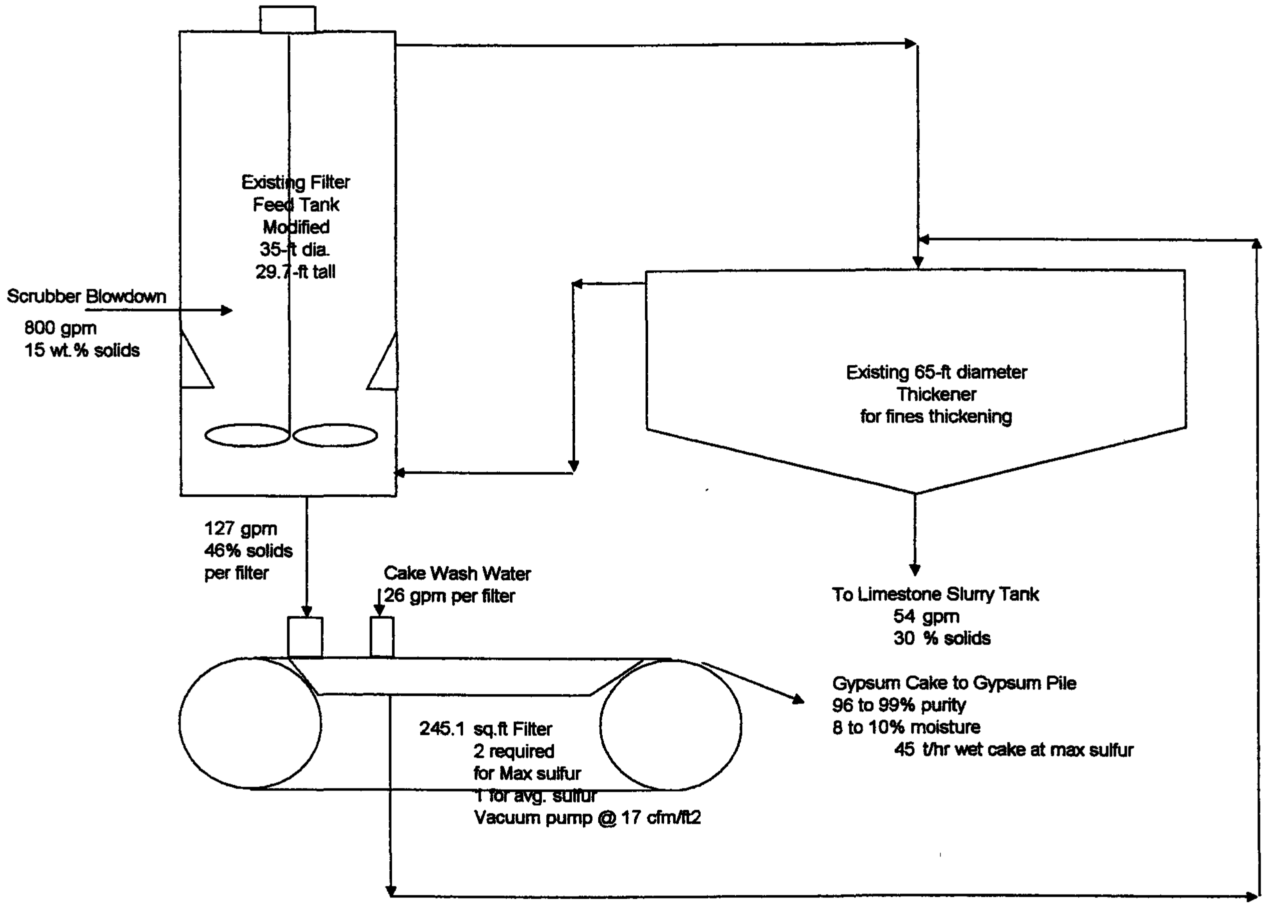
Basis:	**800.00** gpm	Combined total feed slurry to all hydroseparator units		
(Inputs)	**15.00** wt.%	solids in feed slurry		
	2.32 S.G.	solids in feed slurry	1.1136 S.G. Slurry	
	1.02 S.G.	liquor in feed slurry	**2** % dissolved solids to correct TS	
	130.00 F	temperature of slurry (calculations based on aqueous slurry)		
	46.00 wt.%	solids in underflow (input desired or measured concentration)		
	35.00 microns	Desired cut size in microns (size for design rise rate)		
	83.00 %	desired recovery of solids in underflow		
	1.45 ft2/t/d	Req'd Unit Area for Hydroseparator to reach desired u'flow solids conc. **(Adjust for positive rate out of mixing zone.)**		
	1.0 #	Number of hydroseparator units to handle required flow rate		
Results:	965.73 sq.ft.	Calculated or required combined total surface area of all hydroseparators		35.07 Ft. Dia. Ea. Unit
	0.84 wt.%	solids in overflow based on desired recovery		
	11,368 lb/hr	solids in overflow at desired recovery	5.68 ton/hr	
	55,502 lb/hr	total underflow production rate of all units combined	27.75 ton/hr	
Calculations:	4.55 wt.%	Actual feed Conc. Considering dilution water addition to feed slurry and dissolved solids		
	2248.457 gpm/unit	Design overflow rate from hydroseparator required for desired particle size cut		
	1.11 S.G.	feed slurry		
	1.37 S.G.	underflow slurry		
	1114.49 lb/min/unit	solids in feed slurry	802.4 t/d	33.4 t/hr
	6315.45 lb/min/unit	liquor in feed slurry		
	925.03 lb/min/unit	solids in underflow slurry @ desired % recovery	27.75 tons/hr/unit	after subtracting dissolved solids
	175.46 gpm/unit	desired underflow slurry flow rate		
	47.81 gpm/unit	desired volume of solids in underflow slurry		
	127.65 gpm/unit	water in underflow slurry at desired rate		
	5.37 %	percent of water in feed reporting to underflow if no wash		
	1623.92 gpm/unit	wash water flow to bottom of hydroseparator (to give required overflow rate)		
	0.39 %	maximum estimated % of ultra-fines left in underflow		
	1623.92 gpm	total wash/dilution water required to be added to hydroseparators		
	965.73 Ft2/unit	min. hydroseparator size based on thickener unit area requirement		
	965.73 sq. ft.	Combined total surface area of all hydroseparators required		35.07 Ft. Dia. Ea. Unit
	2.33 gpm/ft2	rise rate at overflow	0.1581218 cm/sec.	
	1.55 gpm/ft2	rise rate out of mixing zone	0.1052242 cm/sec.	(Note: negative number indicates slurry flow down into mixing zone)
	0.548720825 centipoise	viscosity of water at temperature		
	35.00 microns	cut size based on rise rate in overflow (using Stoke's law) (particles this size and smaller will tend to flow up from feed point)		
	28.55 microns	cut size based on rise rate out of mixing zone (using Stoke's law, Note: If no number, then net slurry flow down into mixing zone) (particles this size and smaller will tend to flow up out of mixing zone)		
	0.84 wt.%	calculated wt.% solids in overflow based on desired recovery		
	83.00 %	actual recovery of solids in underflow (% of feed solids reporting to underflow) based on measured or estimated overflow solids conc.		
	27.75 t/hr/unit	actual solids production rate in underflow per unit		

PRELIMINARY DESIGN CONCEPT
HYDROSEPARATORS FOR FOG PLANT EXPANSION
(28-ft. diameter by 30-ft. high for 60 t/hr gypsum production)



IP12_000710

SIMPLIFIED FLOWSHEET FOR PRODUCING BYPRODUCT GYPSUM



IP12_000711

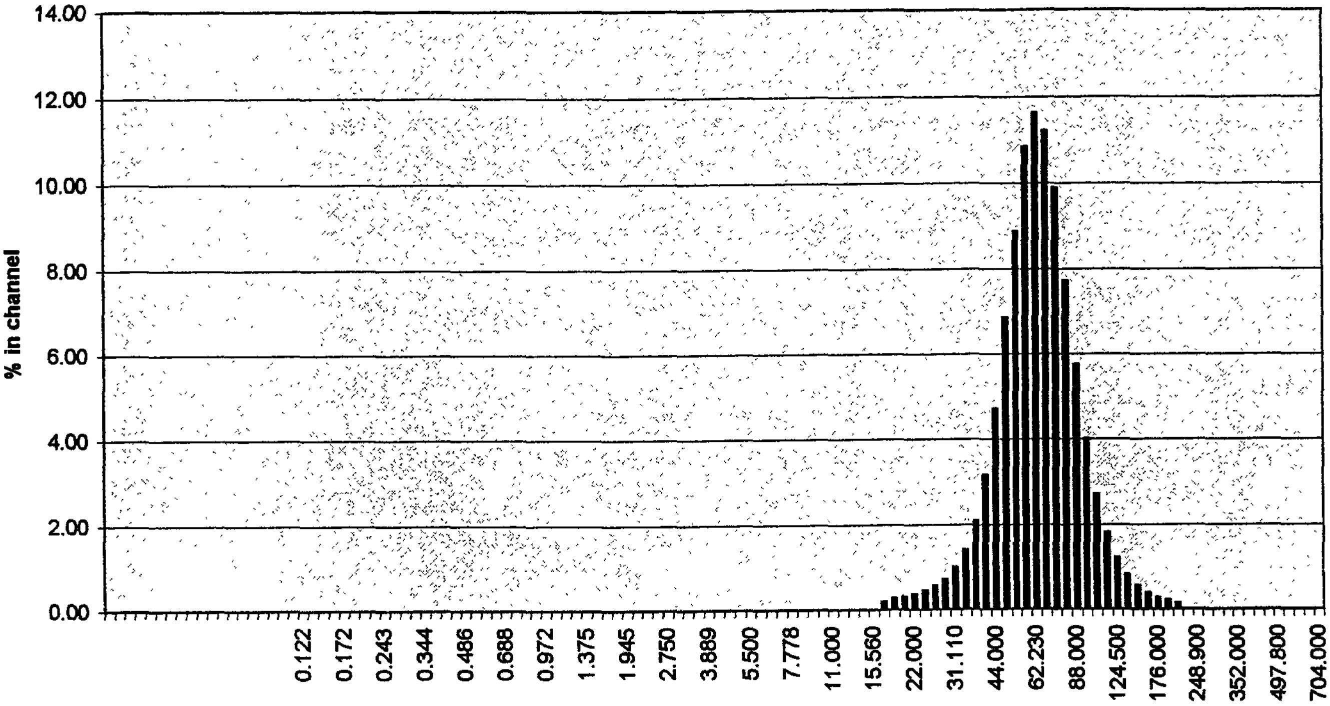
LECOTRAC
Particle Size Analyzer

ENTER NOTES HERE:

in Methanol

ID #1	06-0121	**10%**	39.841
ID #2	IPSC-U1 UF 2/8/6	**50%**	60.692
Date	2/22/06	**90%**	91.699
Time	16:08	**MV**	64.190

size	%pass	size	%pass	size	%pass
200	100.000	**50**	25.590	**5**	0.000
100	93.725	**25**	1.798	**2**	0.000
75	77.680	**10**	0.000	**1**	0.000



size	%chan	%pass	size	%chan	%pass	size	%chan	%pass	size	%chan	%pass
704.000	0.000	100.00	52.330	8.870	30.93	3.889	0.000	0.00	0.289	0.000	0.00
645.600	0.000	100.00	47.980	6.840	22.06	3.566	0.000	0.00	0.265	0.000	0.00
592.000	0.000	100.00	44.000	4.700	15.22	3.270	0.000	0.00	0.243	0.000	0.00
542.900	0.000	100.00	40.350	3.160	10.52	2.999	0.000	0.00	0.223	0.000	0.00
497.800	0.000	100.00	37.000	2.100	7.36	2.750	0.000	0.00	0.204	0.000	0.00
456.500	0.000	100.00	33.930	1.400	5.26	2.522	0.000	0.00	0.187	0.000	0.00
418.600	0.000	100.00	31.110	0.990	3.86	2.312	0.000	0.00	0.172	0.000	0.00
383.900	0.000	100.00	28.530	0.720	2.87	2.121	0.000	0.00	0.158	0.000	0.00
352.000	0.000	100.00	26.160	0.560	2.15	1.945	0.000	0.00	0.145	0.000	0.00
322.800	0.000	100.00	23.990	0.450	1.59	1.783	0.000	0.00	0.133	0.000	0.00
296.000	0.000	100.00	22.000	0.370	1.14	1.635	0.000	0.00	0.122	0.000	0.00
271.400	0.000	100.00	20.170	0.310	0.77	1.499	0.000	0.00		0.000	0.00
248.900	0.000	100.00	18.500	0.280	0.46	1.375	0.000	0.00		0.000	0.00
228.200	0.000	100.00	16.960	0.180	0.18	1.261	0.000	0.00		0.000	0.00
209.300	0.130	100.00	15.560	0.000	0.00	1.156	0.000	0.00		0.000	0.00
191.900	0.220	99.87	14.270	0.000	0.00	1.060	0.000	0.00		0.000	0.00
176.000	0.270	99.65	13.080	0.000	0.00	0.972	0.000	0.00		0.000	0.00
161.400	0.380	99.38	12.000	0.000	0.00	0.892	0.000	0.00		0.000	0.00
148.000	0.550	99.00	11.000	0.000	0.00	0.818	0.000	0.00		0.000	0.00
135.700	0.810	98.45	10.090	0.000	0.00	0.750	0.000	0.00		0.000	0.00
124.500	1.200	97.64	9.250	0.000	0.00	0.688	0.000	0.00		0.000	0.00
114.100	1.810	96.44	8.482	0.000	0.00	0.630	0.000	0.00		0.000	0.00
104.700	2.710	94.63	7.778	0.000	0.00	0.578	0.000	0.00		0.000	0.00
95.960	4.000	91.92	7.133	0.000	0.00	0.530	0.000	0.00		0.000	0.00
88.000	5.750	87.92	6.541	0.000	0.00	0.486	0.000	0.00		0.000	0.00
80.700	7.700	82.17	5.998	0.000	0.00	0.446	0.000	0.00		0.000	0.00
74.000	9.880	74.47	5.500	0.000	0.00	0.409	0.000	0.00		0.000	0.00
67.860	11.200	64.59	5.044	0.000	0.00	0.375	0.000	0.00		0.000	0.00
62.230	11.620	53.39	4.625	0.000	0.00	0.344	0.000	0.00		0.000	0.00
57.060	10.840	41.77	4.241	0.000	0.00	0.315	0.000	0.00		0.000	0.00

![LECO]

LECOTRAC

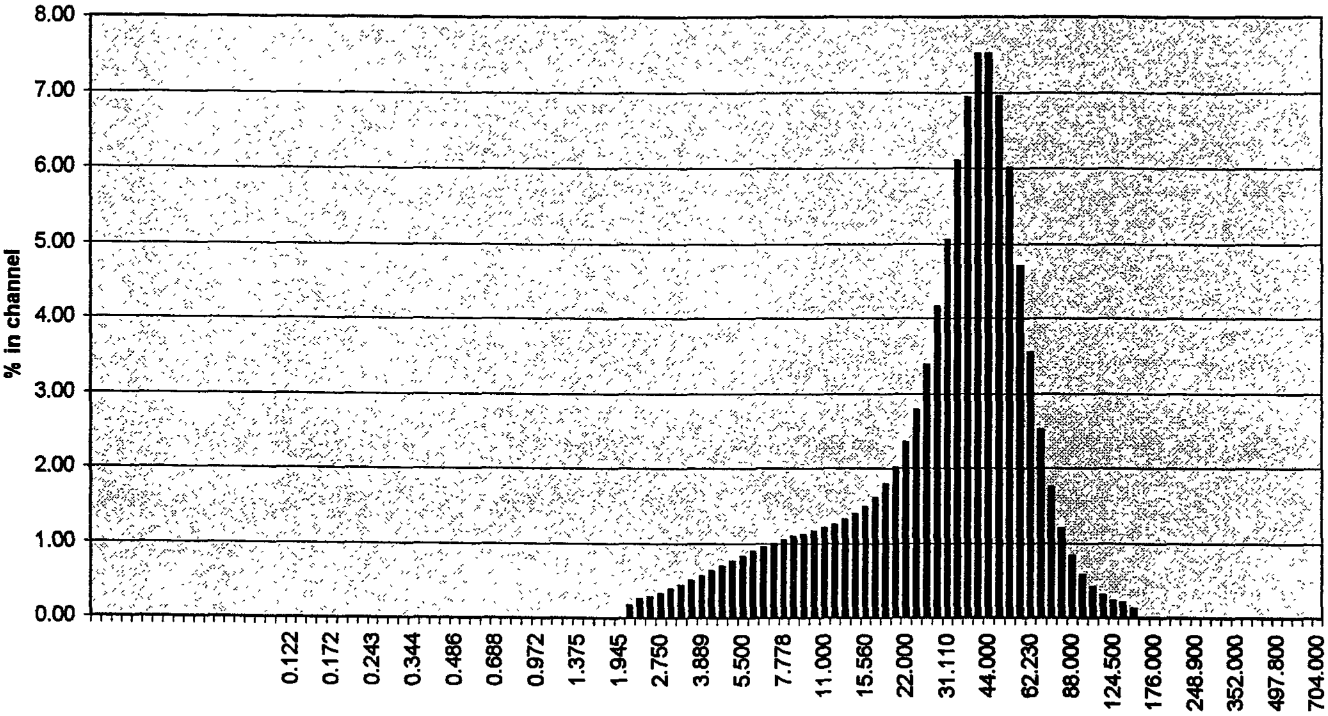
H'SEP O'FLOW **Particle Size Analyzer**

ENTER NOTES HERE:

in Methanol

ID #1	06-0120	**10%**	7.998
ID #2	IPSC-01 OF 2/8/6	**50%**	34.466
Date	2/22/06	**90%**	59.225
Time	15:57	**MV**	35.000

size	%pass	size	%pass	size	%pass
200	100.000	**50**	81.370	**5**	4.901
100	99.000	**25**	31.459	**2**	0.012
75	96.710	**10**	12.881	**1**	0.000



size	%chan	%pass	size	%chan	%pass	size	%chan	%pass	size	%chan	%pass
704.000	0.000	100.00	**52.330**	6.000	83.68	**3.889**	0.560	2.90	**0.289**	0.000	0.00
645.600	0.000	100.00	**47.980**	6.940	77.68	**3.566**	0.500	2.34	**0.265**	0.000	0.00
592.000	0.000	100.00	**44.000**	7.510	70.74	**3.270**	0.440	1.84	**0.243**	0.000	0.00
542.900	0.000	100.00	**40.350**	7.510	63.23	**2.999**	0.380	1.40	**0.223**	0.000	0.00
497.800	0.000	100.00	**37.000**	6.930	55.72	**2.750**	0.320	1.02	**0.204**	0.000	0.00
456.500	0.000	100.00	**33.930**	6.100	48.79	**2.522**	0.280	0.70	**0.187**	0.000	0.00
418.600	0.000	100.00	**31.110**	5.050	42.69	**2.312**	0.250	0.42	**0.172**	0.000	0.00
383.900	0.000	100.00	**28.530**	4.150	37.64	**2.121**	0.170	0.17	**0.158**	0.000	0.00
352.000	0.000	100.00	**26.160**	3.380	33.49	**1.945**	0.000	0.00	**0.146**	0.000	0.00
322.800	0.000	100.00	**23.990**	2.780	30.11	**1.783**	0.000	0.00	**0.133**	0.000	0.00
296.000	0.000	100.00	**22.000**	2.340	27.33	**1.635**	0.000	0.00	**0.122**	0.000	0.00
271.400	0.000	100.00	**20.170**	2.000	24.99	**1.499**	0.000	0.00		0.000	0.00
248.900	0.000	100.00	**18.500**	1.780	22.99	**1.375**	0.000	0.00		0.000	0.00
228.200	0.000	100.00	**16.960**	1.600	21.21	**1.261**	0.000	0.00		0.000	0.00
209.300	0.000	100.00	**15.560**	1.480	19.61	**1.156**	0.000	0.00		0.000	0.00
191.900	0.000	100.00	**14.270**	1.380	18.13	**1.060**	0.000	0.00		0.000	0.00
176.000	0.000	100.00	**13.080**	1.310	16.75	**0.972**	0.000	0.00		0.000	0.00
161.400	0.000	100.00	**12.000**	1.240	15.44	**0.892**	0.000	0.00		0.000	0.00
148.000	0.120	100.00	**11.000**	1.200	14.20	**0.818**	0.000	0.00		0.000	0.00
135.700	0.200	99.88	**10.090**	1.150	13.00	**0.750**	0.000	0.00		0.000	0.00
124.500	0.230	99.68	**9.250**	1.110	11.85	**0.688**	0.000	0.00		0.000	0.00
114.100	0.300	99.45	**8.482**	1.080	10.74	**0.630**	0.000	0.00		0.000	0.00
104.700	0.410	99.15	**7.778**	1.040	9.66	**0.578**	0.000	0.00		0.000	0.00
95.960	0.570	98.74	**7.133**	0.990	8.62	**0.530**	0.000	0.00		0.000	0.00
88.000	0.820	98.17	**6.541**	0.940	7.63	**0.486**	0.000	0.00		0.000	0.00
80.700	1.190	97.35	**5.998**	0.890	6.69	**0.446**	0.000	0.00		0.000	0.00
74.000	1.740	96.16	**5.500**	0.820	5.80	**0.409**	0.000	0.00		0.000	0.00
67.860	2.510	94.42	**5.044**	0.760	4.98	**0.375**	0.000	0.00		0.000	0.00
62.230	3.540	91.91	**4.625**	0.690	4.22	**0.344**	0.000	0.00		0.000	0.00
57.060	4.690	88.37	**4.241**	0.630	3.53	**0.315**	0.000	0.00		0.000	0.00

Thickener/Settling Correlations

File/Project Name	IPSC
Sample/Test No.	2
Polymer Dosage	0.004 lb/ton
Polymer	Polyfloc AE1703
Wt. Of Dry Solids,g	219.4
Initial Ht., ml	2000
Initial Conc.Co, mt/cu.m.	0.1097
Initial ht., m	0.403708609
Wt. Solids/area, g/sq.cm.	4 428683444
depth corr. Exponent	0.6
Solids S.G.	2.32
Liquor S.G.	1.02
Cylinder ml/ft.	1510

Time min.	Height ml	Unit Area sq.ft./t/d	Cu g/l	Cu wt.%	Depth Corr. Factor	Corr. U.A. Sq.ft/t/d	Cu, wt.%	Uncorr. U., sq.ft./t/d	Unit Area m2/t/d	Cu, wt.%
0	2000	0	109.7	10.1436	0.612293	0	10.1436	0	0	10.1436
1	1710	0.15367	128.3041	11.75059	0.557364	0.08565	11.75059	0.15367	0.00874	11.75059
2	1450	0.30734	151.3103	13.6959	0.504849	0.15516	13.6959	0.30734	0.015833	13.6959
3	1230	0.46101	178.374	15.92695	0.457387	0.21086	15.92695	0.46101	0.021516	15.92695
4	1080	0.61468	203.1481	17.91694	0.423054	0.260042	17.91694	0.61468	0.026535	17.91694
5	965	0.76835	227.3575	19.81504	0.395419	0.30382	19.81504	0.76835	0.031002	19.81504
8	790	1.22936	277.7215	23.62341	0.350685	0.431118	23.62341	1.22936	0.043992	23.62341
12	655	1.844039	334.9618	27.73565	0.313391	0.577904	27.73565	1.844039	0.05897	27.73565
16	570	2.458719	384.9123	31.14974	0.288314	0.708884	31.14974	2.458719	0.072335	31.14974
21	490	3.227069	447.7551	35.23142	0.263305	0.849703	35.23142	3.227069	0.086704	35.23142
34	380	5.224778	577.3684	42.97413	0.226054	1.181079	42.97413	5.224778	0.120518	42.97413
42	340	6.454138	645.2941	46.70672	0.21146	1.364793	46.70672	6.454138	0.139265	46.70672
48	320	7.376158	685.625	48.82721	0.203906	1.504046	48.82721	7.376158	0.153474	48.82721
71	290	10.91057	756.5517	52.39532	0.192212	2.097139	52.39532	10.91057	0.213994	52.39532
96	275	14.75232	797.8182	54.38236	0.186183	2.746635	54.38236	14.75232	0.280269	54.38236
150	265	23.05049	827.9245	55.79295	0.182091	4.197288	55.79295	23.05049	0.428295	55.79295
250	260	38.41749	843.8462	56.52605	0.180022	6.915985	56.52605	38.41749	0.705713	56.52605
250	260	38.41749	843.8462	56.52605	0.180022	6.915985	56.52605	38.41749	0.705713	56.52605
250	260	38.41749	843.8462	56.52605	0.180022	6.915985	56.52605	38.41749	0.705713	56.52605
250	260	38.41749	843.8462	56.52605	0.180022	6.915985	56.52605	38.41749	0.705713	56.52605
250	260	38.41749	843.8462	56.52605	0.180022	6.915985	56.52605	38.41749	0.705713	56.52605
250	260	38.41749	843.8462	56.52605	0.180022	6.915985	56.52605	38.41749	0.705713	56.52605
250	260	38.41749	843.8462	56.52605	0.180022	6.915985	56.52605	38.41749	0.705713	56.52605
250	260	38.41749	843.8462	56.52605	0.180022	6.915985	56.52605	38.41749	0.705713	56.52605

WT.% FROM S.G.'S   Wt.%=100(1-sgsl/sgl)/(sgsl/sgs-sgsl/sgl)

26.58814302

Thickener/Settling Correlations

File/Project Name	IPSC		Time min.	Height ml	Unit Area sq.ft./t/d	Cu g/l	Cu wt %	Depth Corr. Factor	Corr. U.A. Sq.ft/t/d	Cu, wt.%	Uncorr. U.. sq.ft./t/d	Unit Area m2/t/d	Cu, wt.%
Sample/Test No.		1	0	2000	0	109.7	10.1436	0.612293	0	10.1436	0	0	10.1436
Polymer Dosage	none		3	1950	0.46101	112.5128	10.38855	0.603062	0.278017	10.38855	0.46101	0.028369	10.38855
Polymer	none		5	1840	0.76835	119.2391	10.97143	0.582414	0.447498	10.97143	0.76835	0.045663	10.97143
Wt. Of Dry Solids,g		219.4	9	1610	1.38303	136.2733	12.42961	0.537572	0.743478	12.42961	1.38303	0.075865	12.42961
Initial Ht., ml		2000	15	1285	2.305049	170.7393	15.30371	0.469551	1.082339	15.30371	2.305049	0.110443	15.30371
Initial Conc.Co, mt/cu.m.		0.1097	25	900	3.841749	243.7778	21.07711	0.379216	1.456852	21.07711	3.841749	0.148658	21.07711
Initial ht., m		0.403708609	37	680	5.685788	322.6471	26.86948	0.320514	1.822372	26.86948	5.685788	0.185956	26.86948
Wt Solids/area, g/sq.cm.		4.428683444	51	550	7.837167	398.9091	32.07885	0.282201	2.211657	32.07885	7.837167	0.225679	32.07885
depth corr. Exponent		0.6	63	485	9.681207	452.3711	35.52233	0.261689	2.533469	35.52233	9.681207	0.258517	35.52233
Solids S.G.		2.32	83	420	12.75461	522.381	39.79398	0.240044	3.061665	39.79398	12.75461	0.312415	39.79398
Liquor S.G.		1.02	94	405	14.44498	541.7284	40.92981	0.234863	3.392586	40.92981	14.44498	0.346182	40.92981
Cylinder ml/ft.		1510	110	392	16.90369	559.6939	41.96797	0.23031	3.893089	41.96797	16.90369	0.397254	41.96797
			126	384	19.36241	571.3542	42.63343	0.227478	4.404527	42.63343	19.36241	0.449442	42.63343
			145	377	22.28214	581.9629	43.23326	0.224981	5.013059	43.23326	22.28214	0.511537	43.23326
			190	370	29.19729	592.973	43.85021	0.222465	6.495381	43.85021	29.19729	0.662794	43.85021
			240	365	36.88079	601.0959	44.30178	0.220657	8.137987	44.30178	36.88079	0.830407	44.30178
			240	365	36.88079	601.0959	44.30178	0.220657	8.137987	44.30178	36.88079	0.830407	44.30178
			240	365	36.88079	601.0959	44.30178	0.220657	8.137987	44.30178	36.88079	0.830407	44.30178
			240	365	36.88079	601.0959	44.30178	0.220657	8.137987	44.30178	36.88079	0.830407	44.30178
			240	365	36.88079	601.0959	44.30178	0.220657	8.137987	44.30178	36.88079	0.830407	44.30178
			240	365	36.88079	601.0959	44.30178	0.220657	8.137987	44.30178	36.88079	0.830407	44.30178
			240	365	36.88079	601.0959	44.30178	0.220657	8.137987	44.30178	36.88079	0.830407	44.30178
			240	365	36.88079	601.0959	44.30178	0.220657	8.137987	44.30178	36.88079	0.830407	44.30178
			240	365	36.88079	601.0959	44.30178	0.220657	8.137987	44.30178	36.88079	0.830407	44.30178

WT.% FROM S.G.'S   Wt.%=100(1-sgsl/sgl)/(sgsl/sgs-sgsl/sgl)

26.58814302

Vacuum Filtration Leaf Tests - IPSC gypsum sludge from sample of 2-1-06

0.074 ft2 leaf with 67062 filter cloth
Air leakage = 0.17 ft3/min

Test No	Form Vac. in. Hg	Dry Vac. in. Hg	Form time seconds	Wash time seconds	Dry time seconds	Cake Cracking?	Dry Air Flow Rate ft3/min/ft2	Filtrate Volume ml	Wash Volume ml
Thickener Underflow Sample for Leaf Tests									
1	19	17	54	0	125	no	4.5	185	0
3	18	15	31	21	40	no	-	144	40
Sample from Settling Tests									
2	18	16	180	300	120	no	8.5	190	75
Flocculated Thickener Underflow									
4	17	15	15	0	60	no	-	118	0
5	18	16	45	0	45	no	-	175	0
Hydroseparator Underflow									
6	18	14	1	2	60	no	13.9	133	50
7	18	14	1	2	120	no	13.9	125	60
Fines from hydroseparator Overflow									
8	19	16	-	-		-	-	205	0

Cake Thick. inches	Wet Weight grams	Tare Weight grams	Dry Weight grams	Cake Solids wt.%	Dry Cake Weight lb/ft2	HBF Full-Scale Rate - 0.8 SUF lb/hr/ft2	dry time per unit cake wt. min/lb/ft2	back calc. feed solids conc. wt.%
Thickener Underflow Sample for Leaf Tests								
0.75	196.6	6.8	164.9	83.3	4.7	75.72	0.44	41.8
0.5	134	6.7	105.1	77.3	2.9	91.69	0.23	42.0
Sample from Settling Tests								
1	294.5	6.7	225.4	76.0	6.5	31.25	0.31	53.8
Flocculated Thickener Underflow								
0.5	121	6.8	102.8	84.1	2.9	109.73	0.35	40.9
0.6875	201.4	6.6	162	79.8	4.6	148.02	0.16	41.6
Hydroseparator Underflow								
0.75	195	6.6	180.6	92.4	5.2	236.76	0.19	63.5
0.75	188.1	6.7	176.5	93.6	5.1	118.34	0.40	68.2
Fines from hydroseparator Overflow								
0.625	182.9	6.6	128.6	69.2	3.6			

INTERMOUNTAIN POWER PLANT SAMPLES: IR ANALYSES

NO.	4/11/2006 SAMPLE ID	GYPSUM (WT%)	CaSO3 (WT%)	CaCO3 (WT%)	Oxidation mole %	Oxidation pH pot	Oxidation O'flow	P - O dOxid.	Susp. Solids Orig. Sample wt.%	d (P-O) susp sol. wt.%
<u>Scrubber Samples</u>										
4	U1B-O	61.5	34	2.5	57.6		57.6	5.7	13.44	-0.31
13	U1B-P	66.5	29	2.5	63.2	63.2			13.13	
15	U1C(O)	60.5	35.5	2	56.1		56.1	-0.8	13.59	-0.01
18	U1C-P	59.5	36	3	55.3	55.3			13.58	
7	U1D-O	54.5	42	1	49.3		49.3	16.1	12.93	1.74
20	U1D-P	68	27	3	65.4	65.4			14.67	
1	U1E-O	62.5	34	2	58.0		58.0	2.0	12.81	1.27
11	U1E-P	64	32	2	60.0	60.0			14.08	
3	U2A-O	65	29.5	3.5	62.3		62.3	3.7	13.28	-0.41
5	U2A-P	68.5	26.5	2.5	66.0	66.0			12.87	
14	U2C(O)	73	23.5	1	70.0		70.0	7.8	9.17	3.46
10	U2C-P	79.5	17	1.5	77.8	77.8			12.63	
12	U2D-O	97	1	0.5	98.6		98.6	0.0	12.46	2.77
6	U2D-P	96.5	1	1.5	98.6	98.6			15.23	
2	U2F(O)	76	21	1.5	73.1		73.1	-4.9	9.31	0.64
8	U2F-P	71.5	25	1.5	68.2	68.2			9.95	
Averages					73.1	74.1	72.4	3.7	12.7	1.14
Standard Deviations					16.0	15.1	15.9	6.4	1.8	1.44
<u>Hydroseparator Samples</u>										
16	TEST1-FEED	67.5	28	2.5	64.4					
19	TEST1-FINES	53	42.5	2.5	48.3					
9	TEST1-C	87	8.5	2.5	88.5					
0	Test 2 - Feed	86.1	11.0	1.3	85.8					
17	TEST2-FINES	66.5	28.5	2.5	63.6					
21	TEST2-C	96	1	2	98.6					

IPSC Scrubber Samples taken 3-31-06
Tested 4-5-06

Sample	pH	Decant vol, ml	Syringe Tare, g	Supernate & tare, g	Volume samp., ml	Supernate S.G.	Settled Vol, ml	Sludge wt & tare, g	Sludge wt. ml	Sludge S.G.	Sludge conc. wt.%	Orig. conc wt.%
U2A - pH pot	6.1	2760	34.5	95.38	60	1.015	840	115.93	60	1.357	44.5	12.87
U2C - pH pot	6.1	2890	34.5	95.11	60	1.010	630	121.5	60	1.450	53.0	12.63
U2D - pH pot	5.9	3025	34.5	96.02	60	1.025	610	129.81	60	1.589	64.0	15.23
U2F - pH pot	6.2	3120	34.5	95.52	60	1.017	540	119.96	60	1.424	51.0	9.95
Averages	6.00	2957.50	34.50	95.57	60	1.02	620	125.66	60	1.519	58.5	13.93
U2A - O'flow	6.2	2420	34.5	96.04	60	1.026	1180	110.58	60	1.268	35.3	13.28
U2C - O'flow	6.1	2870	34.5	95.74	60	1.021	735	111.85	60	1.289	37.5	9.17
U2D - O'flow	5.8	2900	34.5	96.35	60	1.031	640	121.02	60	1.442	52.8	12.46
U2F - O'flow	6.1	2910	34.5	95.33	60	1.014	540	117.7	60	1.387	46.0	9.31
Averages	6.00	2893.33	34.50	95.81	60	1.02	638	116.86	60	1.373	45.4	10.31
U1B - pH pot	6.1	2640	34.5	96.45	60	1.033	1040	114.31	60	1.330	39.0	13.13
U1C - pH pot	6.1	2550	34.5	96.57	60	1.035	1020	114.84	60	1.339	39.8	13.58
U1D - pH pot	6.2	2860	34.5	96.41	60	1.032	880	119.02	60	1.409	49.6	14.67
U1E - pH pot	6.1	2680	34.5	96.1	60	1.027	920	116.25	60	1.363	45.0	14.08
Averages	6.13	2683.33	34.50	96.48	60	1.03	980	116.06	60	1.359	42.8	13.79
U1B - O'flow	6.0	2940	34.5	95.66	60	1.019	780	119.25	60	1.413	50.0	13.44
U1C - O'flow	6.1	2840	34.5	96.2	60	1.028	860	117.38	60	1.381	47.0	13.59
U1D - O'flow	6.1	2750	34.5	96.25	60	1.029	800	117.02	60	1.375	46.2	12.93
U1E - O'flow	6.1	2990	34.5	95.83	60	1.022	750	119.17	60	1.411	49.8	12.81
Averages	6.08	2880.00	34.50	95.99	60	1.02	798	118.21	60	1.395	48.3	13.19
Overall Avg	6.07	2828.84	34.50	95.97	60	1.02	787	118.23	60	1.396	47.4	12.68

Top feed Vol,	Form vac in. Hg	Form Time, sec	50 ml Wash Time, sec	Dry time, sec	Dry Vac, in.Hg	Filtrate vol, ml	Tare, g	wet cake & tare, g	Dry cake & tare, g	Cake wt.% SS	Back calc feed wt.%	Cake Wt. Dry lb/ft2	FSFR HBF, 0.8 SUF, lb/hr/ft2
150	17	90	150	60	15	106	18.28	143.73	102.45	67.09	46.10	2.51	24.1
150	17	98	180	60	15	110	18.23	170.68	132.25	74.79	53.37	3.39	28.9
150	17	20	65	60	15	90	18.37	204.58	166.60	79.60	65.30	4.41	87.6
200	17	140	140	60	15	154	18.23	158.52	121.00	73.26	41.71	3.06	25.9
										73.69	51.62		
										5.16	10.31		
150	17	90	110	60	15	130	18.33	103.45	74.05	65.46	33.42	1.66	18 4
150	17	160	180	60	15	135	18.23	121.18	90.79	70.48	38.26	2.16	15.6
150	17	60	75	60	15	120	18.3	144.04	117.83	79.16	50.49	2.96	43.8
150	17	110	140	60	15	115	18.33	146.07	111.68	73.08	48.11	2.78	25.8
										72.04	42.57		
										5.70	8.08		
150	17	80	90	60	15	120	18.31	134.11	96.85	67.82	41.96	2.34	29.3
150	17	70	80	60	15	120	18.32	135.49	96.03	66.32	41.21	2.31	31.7
150	17	70	90	60	15	108	18.22	158.34	115.42	69.37	48.78	2.89	37.9
150	17	60	95	60	15	115	18.32	131.68	94.82	67.48	42.58	2.28	30.5
										67.75	43.63		
										1.26	3.48		
150	17	60	140	60	15	105	18.2	156.33	113.17	68.75	48.90	2.83	31.3
150	17	60	120	60	15	102	18.26	149.63	106.22	66.96	47.70	2.62	31.4
150	17	58	120	60	15	95	18.33	158.47	112.43	67.15	50.58	2.80	33.9
150	17	65	130	60	15	115	18.31	152.72	109.61	67.93	45.49	2.72	30.7
										67.70	48.17	2.74	31.8
										0.82	2.14		
										70.29	46.50		

Hydroseparator Tests - 4-7-06

Procedure: Composited four of above slurries with **lowest** settled solids density: U2A-O, U2C-O, U1B-P, U1C-P for test 1
Composited four of above slurries with **highest** settled solids density: U2D-P, U2C-P, U2D-O, U2F-P for test 2

<u>Test 1 - finer range of solids</u>

95 F water temperature - used decanted scrubber water from IPP plus 60 F composite sludge
started with approximately 600 ml of sludge in 2-liter cylinder with 1480 ml/ft
pumped water into bottom of cylinder at 300 ml/min or about 36 micron cut size at 88 F equivalent to 2.44 gpm/ft2 at 130 F
11:34 began overflowing cylinder
11:36 coarse at 40 ml
11:39 coarse at 100 ml
11:41 coarse at 150 ml o'flow = 88 F
11:49 stopeed test - overflow liquor = 1.021 s.g. and clear
decanted supernate after 5 min settling - yield 250 ml of sludge with fluid fines at top
settled sludge to about 170 ml and decanted - 1.456 s.g. = 52.5% solids
decanted about 25 additional ml and filtered remainder

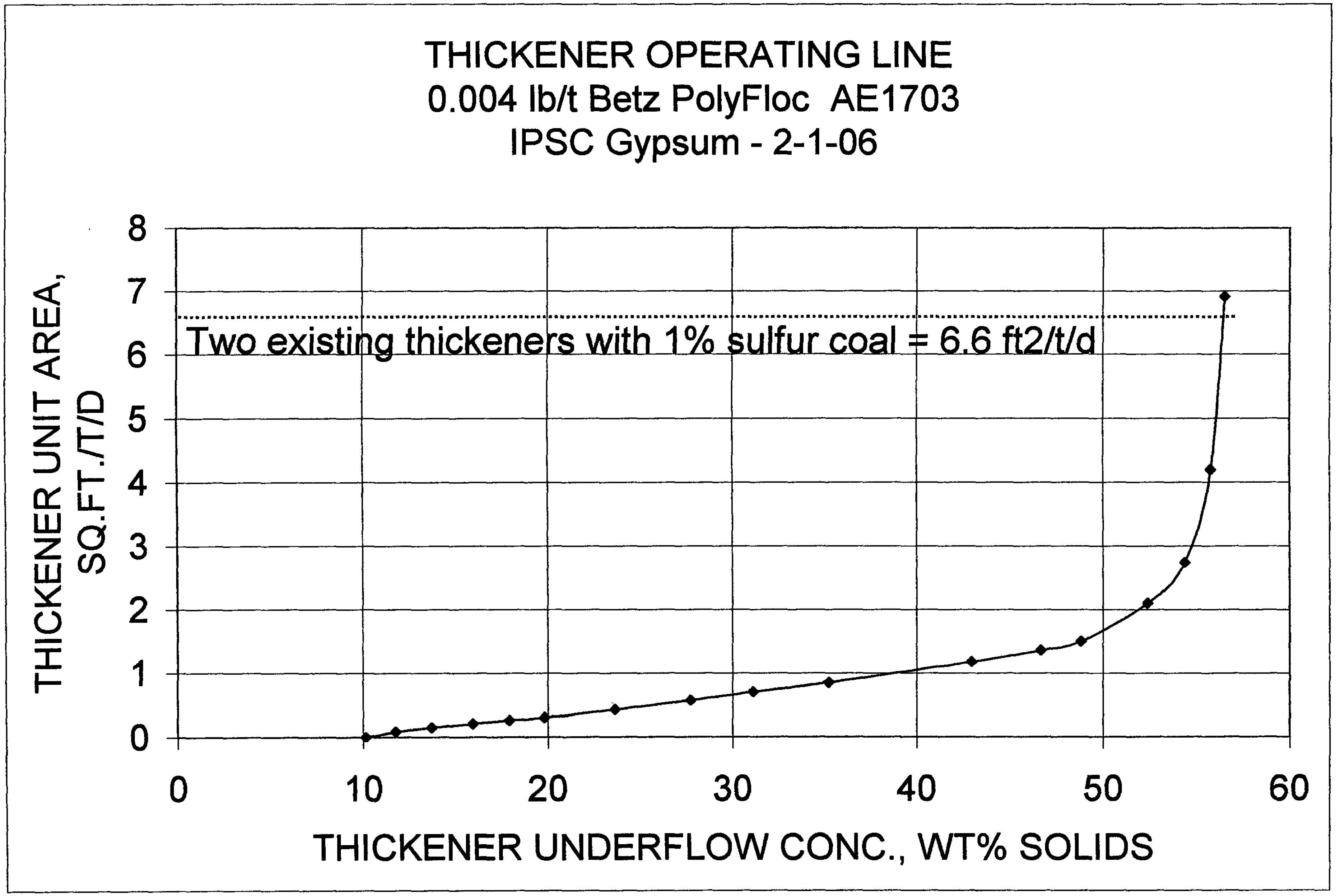
Feed slurry sample filtered to 67.6% cake solids
Coarse slurry sample
FT = 7 sec — 99.8 lb/hr/ft2 full scale filtration rate
WT = 25 sec for 50 ml wash
DT = 70 sec at 17 in Hg
118.72 dry cake solids at 87.5% solids - 9/16"cake with 105 ml filtrate
48.92 % feed solids to filter test
52.67 % of solids in coarse fraction
Overflow solids thickened to 1.40 s.g. - 540 ml filtered
yield 106.67 g dry solids in cake of 65.9% solids
460 ml filtrate
about 18.5% feed solids concentration to filter
47.37 % of solids in overflow

<u>Test 2 - coarser range of solids</u>

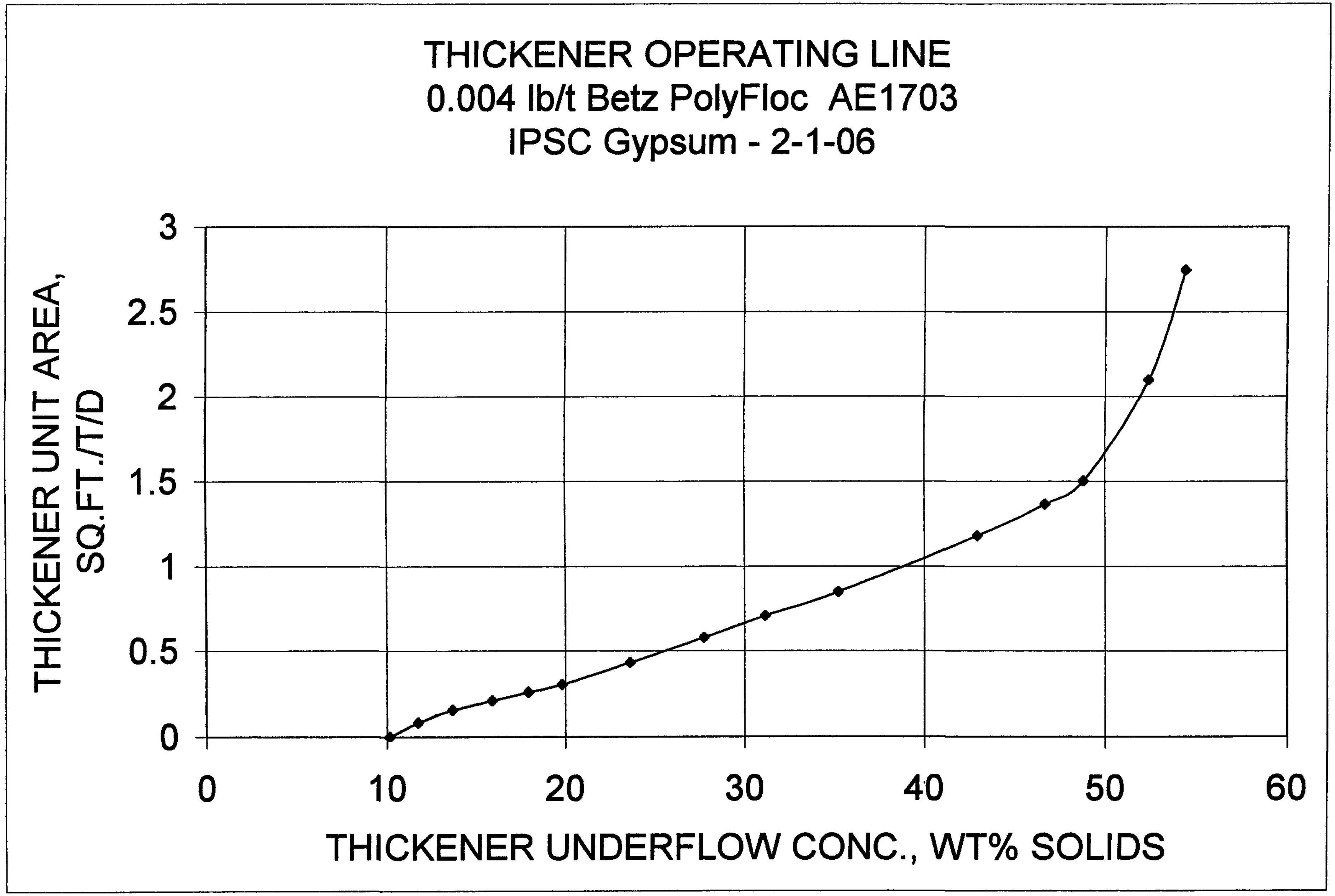
90 F water temperature - same as above otherwise
300 ml/min water into bottom - gives cut size at about 36 microns
1:52 start pumping
1:59 start overflowing
2:13 stopped test as overflow was clear and 1.02 s.g.
270 ml of very coarse settled solids to filter — 388 lb/hr/ft2 full-scale filtration rate
1 sec form time
1 sec wash time for 75 ml
70 sec dry time for 1-7/16 inch cake
190 ml filtrate
348.57 g wet cake
325.93 g dry cake — 93.5 % solids in cake
69.96 % solids in feed slurry to filter
106.6 g dry solids in overflow
131.1 g wet overflow cake solids
81.3 % solids in overflow cake
24.6 % of solids in overflow
75.4 % of solids in coarse underflow fraction

Averaging Test 1 & Test 2
67.58 percent of all solids go to underflow
32.42 percent of all solids go to overflow
91.82 percent solids in filter cake

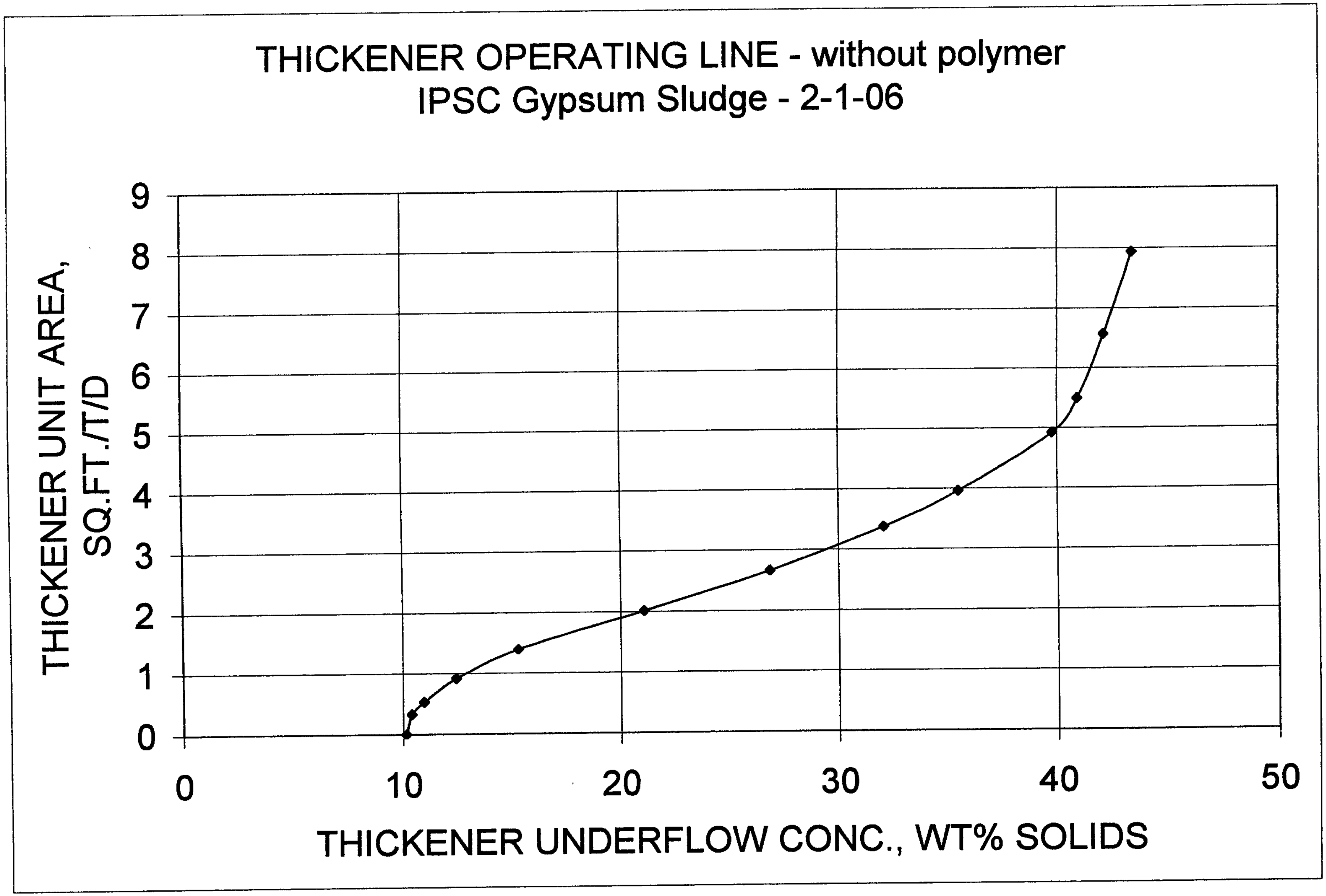
[redacted]


THICKENER OPERATING LINE
0.004 lb/t Betz PolyFloc AE1703
IPSC Gypsum - 2-1-06
Two existing thickeners with 1% sulfur coal = 6.6 ft2/t/d
THICKENER UNIT AREA, SQ.FT./T/D
THICKENER UNDERFLOW CONC., WT% SOLIDS
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60

IP12_000722


THICKENER OPERATING LINE
0.004 lb/t Betz PolyFloc AE1703
IPSC Gypsum - 2-1-06
THICKENER UNIT AREA, SQ.FT./T/D
0
0.5
1
1.5
2
2.5
3
0
10
20
30
40
50
60
THICKENER UNDERFLOW CONC., WT% SOLIDS

IP12_000723


THICKENER OPERATING LINE - without polymer
IPSC Gypsum Sludge - 2-1-06
THICKENER UNIT AREA, SQ.FT./T/D
THICKENER UNDERFLOW CONC., WT% SOLIDS
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50

WesTech
AN EMPLOYEE OWNED COMPANY

BUDGET PROPOSAL FOR:

INTERMOUNTAIN POWER PROJECT
DELTA, UTAH

EQUIPMENT:

GYPSUM HYDROSEPARATOR

PREPARED FOR:

CODAN ASSOCIATES
JIM WILHELM

FURNISHED BY:

WesTech ENGINEERING, INC.
SALT LAKE CITY, UTAH
CONTACT: JIM WOODS
PHONE: (801) 265-1000
FAX: (801) 265-1080

WesTech PROPOSAL NUMBER 061100
MAY 5, 2006

ITEM A – GYPSUM HYDROSEPARATOR MECHANISM

One (1) 35'-0 diameter WesTech Hydroseparator Mechanism suitable for installation in IPP's existing 35'-0 diameter x 30'-0 flat bottom tank.

Coordination and Engineering: WesTech will provide all support engineering and drawings required for use by the contractor for installation of nozzles, clips, etc. necessary for installation of WesTech supplied tank internals, supports, and mixer.

Mixer: One (1) Hydroseparator Mixer manufactured by Mixtec North America as follows:

Description	**Design**
- Application	Industrial
- Product Description	Hydroseparator Agitator
- Viscosity (cp)	1
- Design Basis (Intank Velocity) (ft/min)	39.7
- Specific Gravity (Liquid)	1
- Specific Gravity (Solids)	4
- % Solids	35
- Specific Gravity (Design)	1.36
- Installed HP @ Shaft RPM	60 HP @ 25 RPM
- Speed Reducer	Parallel Helical
- Shaft Diameter (in.) X Length (in.)	8.62" O.D., 6.81" I.D. x 246.57"
- Impeller Diameter (in.) / Type	161.42" Dia. / HA715 – 3 Blade Hydrofoil
- Number of Impellers	One (1)
- Materials of Wet Ends	Carbon Steel with Soft Natural Rubber Coating
- Weight, lbs. (Each)	4,400

Mechanism Support: The beam type mechanism support spans the tank and is supported by the tank walls. A walkway of 1-1/4" x 1/8" steel grating, 36" wide, extends from the ladder/stairway access to the drive platform. Handrails of double row horizontal 1-1/4" diameter pipe with kickplate are included.

Caged Ladder with Rest Platform: A caged ladder with integral rest platform will be supplied for installation to the existing tank. The ladder will extend from grade to the mechanism support at the top of the tank. An access gate is included at the top of the caged ladder.

Fasteners: Submerged Fasteners, Monel; Non-Submerged Fasteners, HDG.

Slurry Feed Pipe: Two (2) each 12" diameter FRP feed pipes extending from the tank wall to 12" inside the conical baffle.

Wash Water Inlet: A 10" diameter FRP wash water pipe and supports. The wash water pipe will extend from just above the impeller to the edge of the tank wall.

Shaft Deflection Limiting Ring: One (1) Shaft Deflection Limiting Ring fabricated of 12" schedule 120 Monel pipe including mounting plate and gussets for installation in the separator tank prior to coating by others. The pipe will be open at the bottom allowing any solids to free flow and not become trapped within the pipe.

Surface Preparation and Painting for non-FRP items:

All non-submerged fabricated steel (Mixer Support/Walkway):
Sandblasted to SSPC-SP10 (near white), painted with
(1) coat of Carboline Carbozinc 859, 3 to 5 mils DFT,
(1) coat of Carboline Carboguard 890, 5 to 7 mils DFT, and
(1) coat of Carboline Carbothane 133LH, 3 to 6 mils DFT.
Total Dry Film Thickness is 11-18 mils.

Baffles: Four (4) FRP vertical baffles 36" x 120" x ¼" at 6" off side wall including supports.

Interior Cone: A 120" sloped x 1/4" interior cone on an 80° angle fabricated from FRP Flat Plates and Supports.

Submerged Pipe Launders: Two (2) 18" x 35' submerged pipe launders with orifices as required for uniform overflow from the unit.

Control Panel: The control panel will be Nema 4 (painted steel) enclosure and will include mixer drive start – stop push buttons, contacts for remote indication and control (Cutler – Hammer components). Motor starters are not included.

Shipment/Extended Storage: Major steel components will be shipped as soon as fabricated, often before drive, motors, and other manufactured parts. Extended storage instructions will be part of the information provided, and if equipment installation and start-up are delayed more than 30 days, the provisions of these instructions must be followed to keep WARRANTY in force.

NOTE: ANY ITEM NOT LISTED ABOVE TO BE FURNISHED BY OTHERS.

ITEMS NOT BY WESTECH: Electrical wiring, conduit, piping, valves or fittings, lubricating oil or grease, NACE grinding requirements, field painting, field welding, erection, assembly of component handrail, detail shop fabrication drawings, performance testing, unloading, storage, concrete work (except as specifically noted).

WesTech has included all supports required for installation of WesTech supplied internals. WesTech has not included for any modifications to the existing tank i.e. nozzles, drains, coating.

WesTech would recommend the tank be field rubber lined after installation of WesTech and customer supplied nozzles, clips, etc. The tank internals would then be installed after rubber lining is completed.

BUDGET PRICING

Unless otherwise indicated, prices listed below are for equipment only. All optional items will be offered with the purchase of the scoped equipment only. Prices are valid for 30 days. WesTech reserves the right to adjust material pricing at time of order due to the volatility of the steel market.

ITEM	EQUIPMENT	PRICE (U.S. $)
"A"	One (1) 35'-0 diameter WesTech HydroSeparator Mechanism Internals	$ 279,500.00

Equipment Payment Terms: Terms for equipment are 15 percent payment of the purchase price with submittal drawings, 35 percent upon receipt of major material in shop, and 50 percent net 30 days from shipment.

O & M Manuals: Operation and maintenance manuals are included in the above equipment. Withholding of payment for approval of manuals is acceptable, but shall not exceed $750.00 or as mutually agreed to in any resulting purchase order.

Sales Tax: No sales taxes, use taxes, or duties have been included in our pricing.

Freight: Prices quoted are FOB shipping point with freight pre-paid and added to customer invoice at cost. Receiver must initiate any claims for damage upon receipt of material.

Field Service: Prices do not include field service unless noted in equipment description and as broken out as a separate item. Additional field service is available at $750.00 per day plus expenses.

Shipment/Extended Storage: If equipment installation and start-up are delayed more than 30 days, extended storage instructions must be requested from WesTech and the provisions of these instructions must be followed to keep WARRANTY in force.

Terms and Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement. Otherwise, the proposal terms and conditions contained herein shall apply.

WARRANTY

WesTech equipment is backed by WesTech's reputation as a quality manufacturer, and by many years of experience in design of reliable equipment.

Equipment manufactured and sold by WesTech Engineering, Inc., once paid for in full, is backed by the following warranty:

For the benefit of the original user, WesTech warrants all new equipment manufactured by WesTech Engineering, Inc. to be free from defects in material and workmanship; and will replace or repair, F.O.B. at its factories or other location designated by it, any part or parts returned to it which WesTech's examination shall show to have failed under normal use and service by the original user within one (1) year following initial start-up, or eighteen (18) months from shipment to the purchaser, whichever occurs first. Such repair or replacement shall be free of charge for all items except for those items, such as resin, filter media and the like that are consumable and normally replaced during maintenance with respect to which repair or replacement shall be subject to pro-rata charge based upon WesTech's estimate of the percentage of normal service life realized from the part. WesTech's obligation under this warranty is conditioned upon its receiving prompt notice of claimed defects, which shall in no event be later than thirty (30) days following expiration of the warranty period; and is limited to repair or replacement as aforesaid.

THIS WARRANTY IS EXPRESSLY MADE BY WESTECH AND ACCEPTED BY PURCHASER IN LIEU OF ALL OTHER WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WHETHER WRITTEN, ORAL, EXPRESS, IMPLIED, OR STATUTORY. WESTECH NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER LIABILITY WITH RESPECT TO ITS EQUIPMENT. WESTECH SHALL NOT BE LIABLE FOR NORMAL WEAR AND TEAR, NOR FOR ANY CONTINGENT, INCIDENTAL, OR CONSEQUENTIAL DAMAGE OR EXPENSE DUE TO PARTIAL OR COMPLETE INOPERABILITY OF ITS EQUIPMENT FOR ANY REASON WHATSOEVER.

This warranty shall not apply to equipment or parts thereof which have been altered or repaired outside of a WesTech factory, or damaged by improper installation, application, or maintenance, or subjected to misuse, abuse, neglect, accident, or incomplete adherence to all manufacturer's requirements, including, but not limited to, Operations & Maintenance Manual guidelines & procedures.

This warranty applies only to equipment made or sold by WesTech Engineering, Inc.

WesTech Engineering, Inc. makes no warranty with respect to parts, accessories, or components manufactured by others. The warranty which applies to such items is that offered by their respective manufacturers.

Terms and Conditions appearing in any order based on this proposal which are inconsistent herewith shall not be binding on WesTech. The sale and purchase of equipment described herein shall be governed exclusively by the foregoing proposal and the following provisions:

1. SPECIFICATIONS: WesTech Engineering Inc. is furnishing its standard equipment as outlined in the proposal and as will be covered by final approved drawings. The equipment may not be in strict compliance with the Engineer's/Owner's plans, specifications, or addenda as there may be deviations. The equipment will, however, meet the general intention of the mechanical specifications of these documents.

2. ITEMS INCLUDED: This proposal includes only the equipment specified herein and does not include erection, installation, detail shop fabrication drawings, accessory or associated materials such as controls, piping, etc., unless specifically listed.

3. PARTIES TO CONTRACT: WesTech Engineering Inc. is not a party to or bound by the terms of any contract between WesTech's customer and any other party. WesTech's undertakings are limited to those defined in the contract between WesTech and its direct customers.

4. PRICE AND DELIVERY: All selling prices quoted are subject to change without notice after 30 days from the date of this proposal unless specified otherwise.

Unless otherwise stated, all prices are F.O.B. WesTech or its supplier's shipping points. All claims for damage, delay or shortage arising from such equipment shall be made by Purchaser directly against the carrier. When shipments are quoted F.O.B. jobsite or other designation, Purchaser shall inspect the equipment shipped, notifying WesTech of any damage or shortage within forty-eight hours of receipt, and failure to so notify WesTech shall constitute acceptance by Purchaser, relieving WesTech of any liability for shipping damages or shortages.

5. PAYMENTS: All invoices are net 30 days. Delinquencies are subject to a 1.5 percent service charge per month or the maximum permitted by law, whichever is less on all past due accounts. Pro rata payments are due as shipments are made. If shipments are delayed by the Purchaser, invoices shall be sent on the date when the Company is prepared to make shipment and payment shall become due under standard invoicing terms. If the work to be performed hereunder is delayed by the Purchaser, payments shall be based on the purchase price and percentage of completion. Products held for the Purchaser shall be at the risk and expense of the Purchaser. Unless specifically stated otherwise, prices quoted are for equipment only. These terms are independent of and not contingent upon the time and manner in which the Purchaser receives payment from the owner.

6. PAYMENT TERMS: Credit is subject to acceptance by our Credit Department if the financial condition of the Purchaser at any time is such as to give the Company, in its judgement, doubt concerning the Purchaser's ability to pay. The Company may require full or partial payment in advance or may suspend any further deliveries or continuance of the work to be performed by the Company until such payment has been received.

7. ESCALATION: If shipment is, for any reason, deferred by the customer beyond the normal shipment date, or if material price increases are greater than 10 percent from proposal date to material procurement date, stated prices set forth herein are subject to escalation. The escalation shall be based upon increases in labor and material and other costs to WesTech that occur in the time period between quotation and shipment by WesTech, except as hereinafter set forth in subparagraph (b) below.

(a) The total quoted revised price is based upon changes in the indices published by the United States Department of Labor, Bureau of Labor Statistics. Labor will be related to the Average Hourly Earnings indices found in the Employment and Earnings publication and material will be related to the Metal and Metal Products indices published in wholesale Prices and Prices Indices.

(b) Price revision for items furnished to, and not manufactured by WesTech, which exceed the above escalation calculation will be passed along by WesTech to Buyer based upon the actual increase in price to WesTech for the period from the date of quotation to the date of shipment by WesTech. Any item that is so revised will be excluded from the index escalation calculations set forth in subparagraph (a) above.

8. APPROVAL: If approval of equipment submittals by Purchaser or others is required, a condition precedent to WesTech supplying any equipment shall be such complete approval.

9. INSTALLATION SUPERVISION: Prices quoted for equipment do not include Installation supervision. WesTech recommends and will, upon request, make available, at WesTech's then current rate, an experienced installation supervisor to act as the Purchaser's employee and agent to supervise installation of the equipment. Purchaser shall at its sole expense furnish all necessary labor equipment, and materials needed for installation.

Responsibility for proper operation of equipment if not installed by WesTech or installed in accordance with WesTech's instruction, inspected and accepted in writing by WesTech, rests entirely with Purchaser; and any work performed by WesTech personnel in making adjustment or changes must be paid for at WesTech's then current per diem rates plus living and traveling expenses.

WesTech will supply the safety devices described in this proposal or shown in WesTech's drawings furnished as part of this order but excepting these, WesTech shall not be required to supply or install any safety devices whether required by law otherwise. The Purchaser hereby agrees to indemnify and hold harmless WesTech from any claims or losses arising due to alleged or actual insufficiency or inadequacy or the safety devices offered or supplied hereunder, whether specified by WesTech or Purchaser, and from any damage resulting from use of the equipment supplied hereunder.

10. ACCEPTANCE OF PRODUCTS: Products will be deemed accepted without any claim by purchaser unless written notice of non-acceptance is received by WesTech within 30 days of delivery if shipped F.O.B. point of shipment, or 48 hours of delivery if shipped F.O.B. point of destination. Such written notice shall not be considered received by WesTech unless it is accompanied by all freight bills for such shipment, with Agent's notations as to damages, shortages and conditions of equipment, containers, and seals. Non-accepted products are subject to the return policy stated below.

11. TAXES: Any federal, state, or local sales, use or other taxes applicable to this transaction, unless specifically included in the price shall be for Purchaser's account.

12. TITLE: The equipment specified herein, and any replacements or substitutes therefore shall, regardless of the manner in which affixed to or used in connection with realty, remain the sole and personal property of WesTech until the full purchase price has been paid. Purchaser agrees to do all things necessary to protect and maintain WesTech's title and interest in and to such equipment; and upon Purchaser's default, WesTech may retain as liquidated damages any and all partial payments made and shall be free to enter the premises where such equipment is located and remove the same as its property without prejudice to any further claims on account of damages or loss which WesTech may suffer from any cause.

13. INSURANCE: From date of shipment until the invoice is paid in full, Purchaser agrees to provide and maintain at its expense, but for WesTech's benefit, adequate insurance on the equipment against any loss of any nature whatsoever.

14. SHIPMENTS: Any shipment or delivery dates recited represent WesTech's best estimate but no liability, direct or indirect, is assumed by WesTech for failure to ship or deliver on such dates.

WesTech shall have the right to make partial shipments; and invoices covering the same shall be due and payable by Purchaser in accordance with the payment terms thereof. If Purchaser defaults in any payment when due hereunder, WesTech may, without incurring any liability therefore to Purchaser or Purchaser's customers, declare all payments immediately due and payable with maximum legal interest thereon from due date of said payment, and at its option, stop all further work and shipments until all past due payments have been made, and/or require that any further deliveries be paid for prior to shipment.

If Purchaser requests postponements of shipments, the purchase price shall be due and payable upon notice from WesTech that the equipment is ready for shipment; and thereafter any storage or other charge WesTech incurs on account of the equipment shall be for the Purchaser's account.

If delivery is specified at a point other than WesTech or its supplier's shipping points, and delivery is postponed or prevented by strike, accident, embargo, or other cause beyond WesTech's reasonable control and occurring at a location other than WesTech or its supplier's shipping points.

If Purchaser refuses such delivery WesTech may store the equipment at Purchaser's expense. For all purposes of this agreement such tender of delivery or storage shall constitute delivery.

15. WARRANTY: WESTECH WARRANTS EQUIPMENT IT SUPPLIES ONLY IN ACCORDANCE WITH THE WARRANTY EXPRESSED IN THE ATTACHED COPY OF WESTECH WARRANTY AGAINST DEFECTS IN WORKMANSHIP AND MATERIALS WHICH IS MADE A PART HEREOF. SUCH WARRANTY IN LIEU OF ALL OTHER WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WHETHER WRITTEN, ORAL, EXPRESS, IMPLIED OR STATUTORY, AND WESTECH SHALL NOT BE LIABLE FOR ANY CONTINGENT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES FOR ANY REASON WHATSOEVER.

16. PATENTS: WesTech agrees that it will, at its own expense, defend all suits or proceedings instituted against Purchaser and pay any award of damages assessed against it in such suits or proceedings, so far as the same are based on any claim that the said equipment or any part thereof constitutes an infringement of any apparatus patent of the United States issued at the date of this Agreement, provided WesTech is given prompt notice in writing of the institution or threatened institution of any suit or proceeding and is given full control of the defense, settlement, or compromise of any such action; and Purchaser agrees to give WesTech needed information, assistance, and authority to enable WesTech so to do. In the event said equipment is held or conceded to infringe such a patent, WesTech shall have the right at its sole option and expense to a) modify the equipment to be non-infringing, b) obtain for Purchaser the license to continue using said equipment, or c) accept return of the equipment and refund to the Purchaser the purchase price thereof less a reasonable charge for the use thereof. WesTech will reimburse Purchaser for actual out-of-pocket expenses, exclusive of legal fees, incurred in preparing such information and rendering such assistance at WesTech's request. The foregoing states the entire liability of WesTech, with respect to patent infringement; and except as otherwise agreed to in writing, WesTech assumes no responsibility for process patent infringement.

17. SURFACE PREPARATION AND PAINTING: If furnished, shop primer paint is intended to serve only as minimal protective finish. WesTech will not be responsible for condition of primed or finish painted surfaces after equipment leaves its shops. Purchasers are invited to inspect paint in shops for proper preparation and application prior to shipment. WesTech assumes no responsibility for field surface preparation or touch up of shipping damage to paint. Painting of fasteners and other touch-up to painted surfaces will be by Purchaser's painting contractor after mechanism installation.

Motors, gear motors, and other components not manufactured by WesTech will be painted with that manufacturer's standard paint system. It is our intention to ship major steel components as soon as fabricated, often before drive, motors, and other manufactured components. Unless you can insure that shop primed steel shall be field painted within thirty (30) days after arrival at the jobsite, we encourage you to purchase these components bare.

Our prices are based on paints and surface preparations as outlined in the main body of this proposal. In the event that an alternate paint system is selected, we request that your order advise of your selection. With your agreement, we will then either adjust our price as may be necessary to comply or ship the material unpainted if compliance is not possible due to application problems or environmental controls.

18. CANCELLATION, SUSPENSION, OR DELAY: After acceptance by WesTech, this proposal, or Purchaser's order based on this proposal, shall be a firm agreement and is not subject to cancellation, suspension, or delay except upon payment by Purchaser of appropriate charges which shall include all costs incurred by WesTech to date of cancellation, suspension, or delay plus a reasonable profit. Additionally, all charges related to storage and/or resumption of work, at WesTech's plant or elsewhere, shall be for Purchaser's sole account; and all risks incidental to storage shall be assumed by Purchaser.

19. RETURN OF PRODUCTS: No product may be returned to WesTech without our prior written permission, said permission may be withheld by WesTech at its sole discretion.

20. BACKCHARGES: WesTech will not approve or accept backcharges for labor, materials, or other costs incurred by Purchaser or others in modification, adjustment, service, or repair of WesTech-furnished materials unless such back charge has been authorized in advance in writing by a WesTech employee, by a WesTech purchase order, or work requisition signed by WesTech.

21. ENTIRE AGREEMENT: This proposal expresses the entire agreement between the parties hereto superseding any prior understandings, and is not subject to modification except by a writing signed by an authorized officer of each party.

22. MOTORS AND MOTOR DRIVES: In order to avoid shipment delays of our equipment, the motor drives may be sent directly to the jobsite for installation by the equipment erector. Minor fit-up may be required.

23. EXTENDED STORAGE: Extended storage instructions will be part of information provided to shipment. If equipment installation and start-up is delayed more than 30 days, the provisions of the storage instructions must be followed to keep WARRANTY in force.

24. ARBITRATION NEGOTIATION: Any controversy or claim arising out of or relating to the performance of any contract resulting from this proposal or contract issued, or the breach thereof, shall be settled by arbitration in accordance with the Construction Industry, Arbitration Rules of the American Arbitration Association, and judgement upon the award rendered by the arbitrator(s) may be entered to any court having jurisdiction.

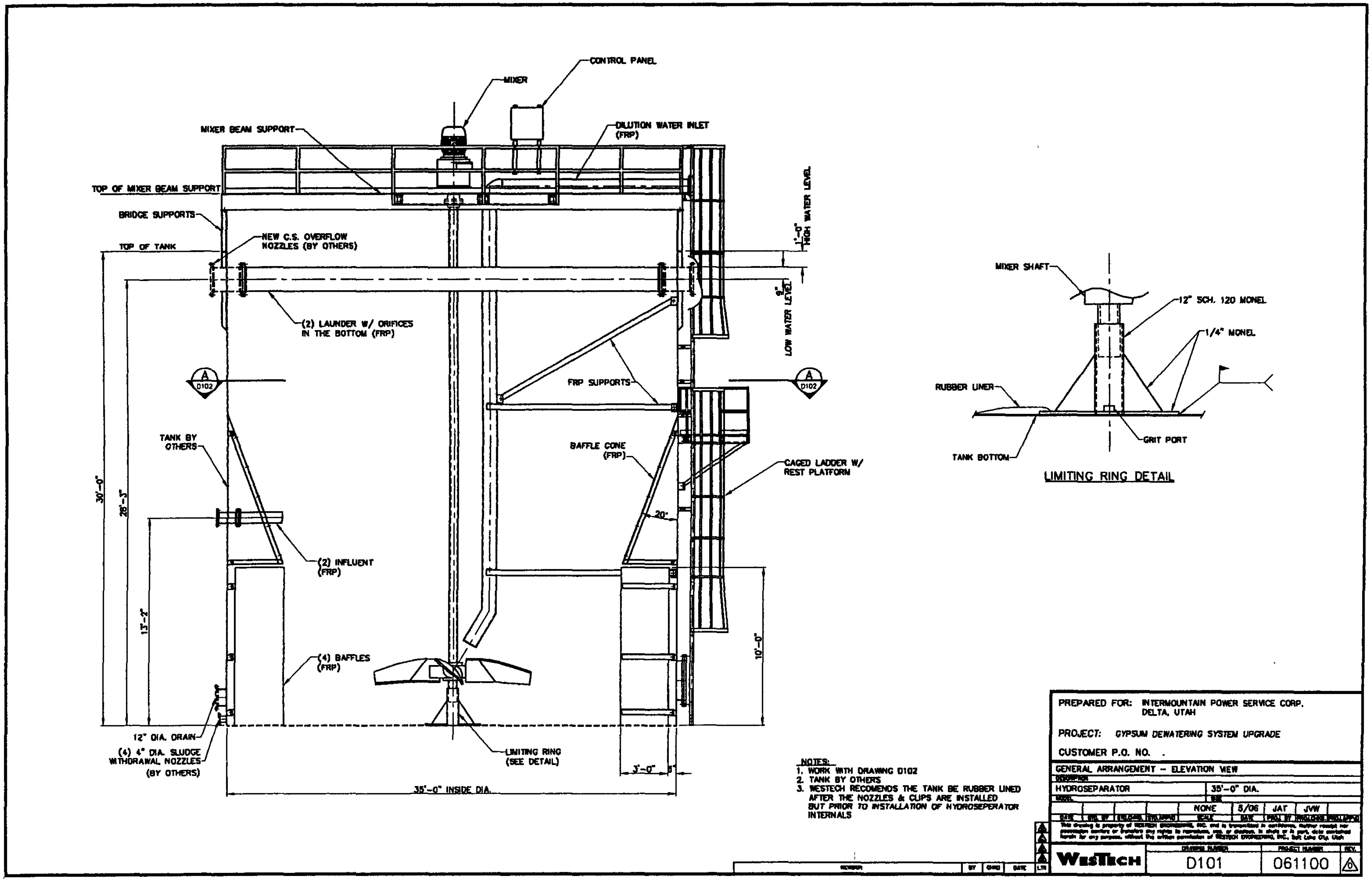
25. LIABILITY: Liability for errors and omissions shall be limited to the greater of $50,000 or the value of the particular piece of equipment (not the value of the entire order) supplied by WesTech against which a claim is sought.

ACCEPTED BY PURCHASER

BY

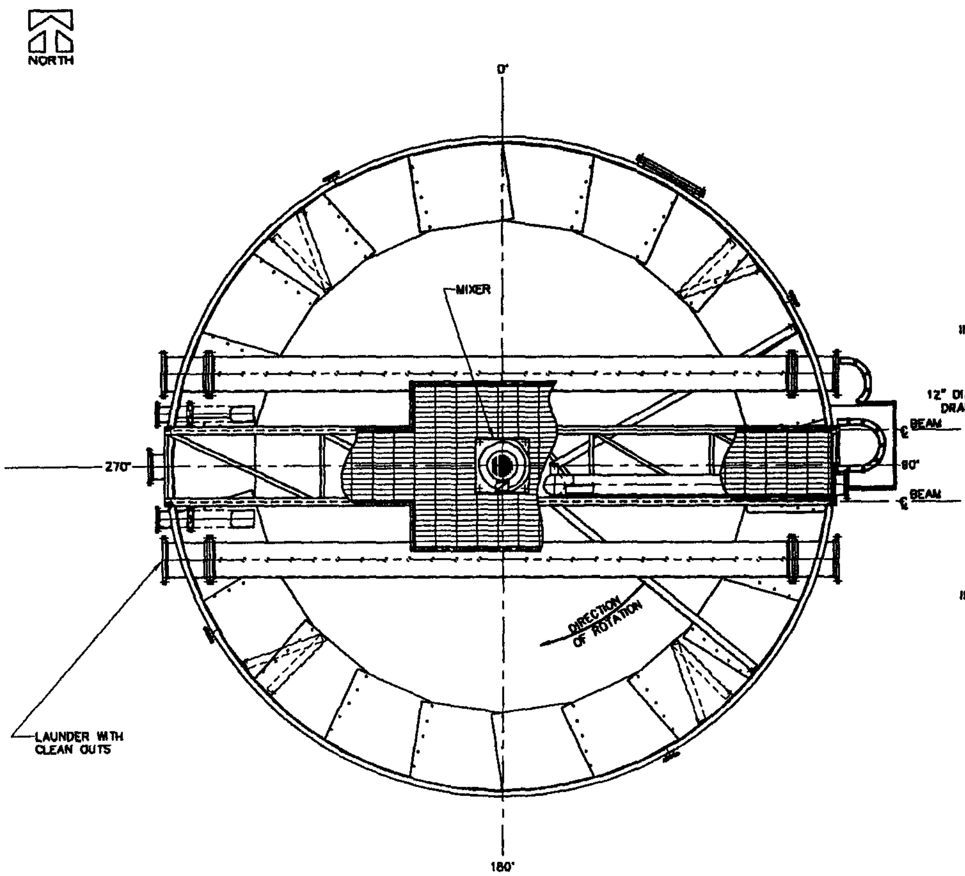
TITLE

DATE

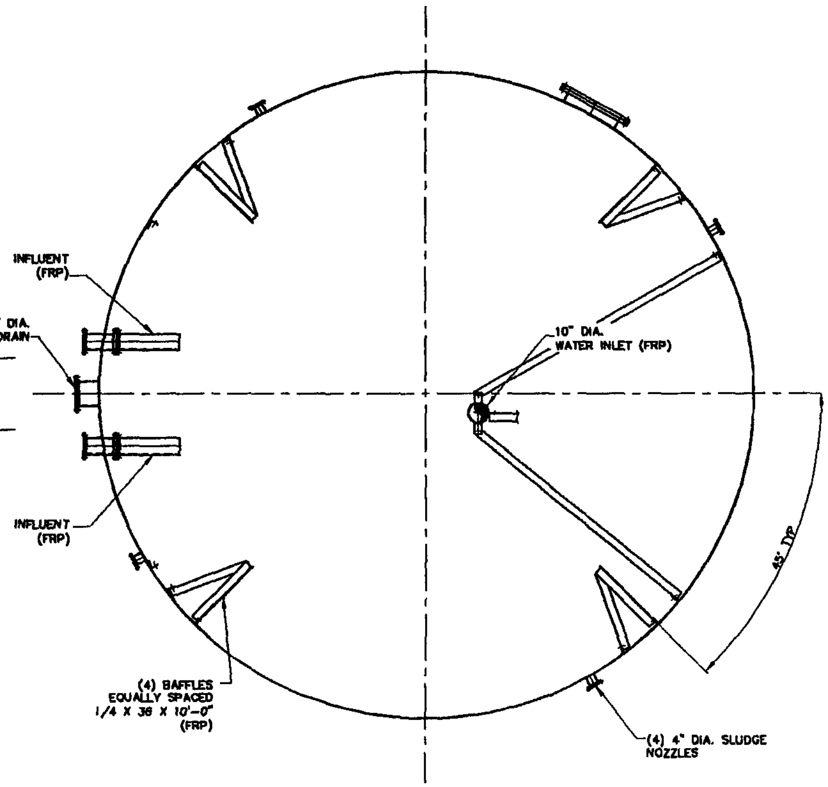


CONTROL PANEL
MIXER
MIXER BEAM SUPPORT
DILUTION WATER INLET (FRP)
TOP OF MIXER BEAM SUPPORT
BRIDGE SUPPORTS
NEW C.S. OVERFLOW NOZZLES (BY OTHERS)
TOP OF TANK
1'-0" HIGH WATER LEVEL
9" LOW WATER LEVEL
(2) LAUNDER W/ ORIFICES IN THE BOTTOM (FRP)
FRP SUPPORTS
A D102
TANK BY OTHERS
BAFFLE CONE (FRP)
CAGED LADDER W/ REST PLATFORM
20°
30'-0"
28'-3"
(2) INFLUENT (FRP)
13'-2"
10'-0"
(4) BAFFLES (FRP)
12" DIA. DRAIN
(4) 4" DIA. SLUDGE WITHDRAWAL NOZZLES (BY OTHERS)
LIMITING RING (SEE DETAIL)
3'-0"
35'-0" INSIDE DIA.
MIXER SHAFT
12" SCH. 120 MONEL
1/4" MONEL
RUBBER LINER
GRIT PORT
TANK BOTTOM
LIMITING RING DETAIL
NOTES:
1. WORK WITH DRAWING D102
2. TANK BY OTHERS
3. WESTECH RECOMENDS THE TANK BE RUBBER LINED AFTER THE NOZZLES & CLIPS ARE INSTALLED BUT PRIOR TO INSTALLATION OF HYDROSEPERATOR INTERNALS
PREPARED FOR: INTERMOUNTAIN POWER SERVICE CORP. DELTA, UTAH
PROJECT: GYPSUM DEWATERING SYSTEM UPGRADE
CUSTOMER P.O. NO. .
GENERAL ARRANGEMENT – ELEVATION VIEW
HYDROSEPARATOR
35'-0" DIA.
NONE
5/06
JAT
JVW
WESTECH
D101
061100

IP12_000733



PLAN VIEW



SECTION "A-A
FRP BAFFLE CONE & MIXER (NOT SHOWN FOR CLARITY)

NOTES:
1. WORK WITH DRAWING D101

PREPARED FOR: INTERMOUNTAIN POWER SERVICE CORP.
DELTA, UTAH

PROJECT: GYPSUM DEWATERING SYSTEM UPGRADE

CUSTOMER P.O. NO. .

GENERAL ARRANGEMENT - PLAN VIEW

HYDROSEPARATOR | 35'-0" DIA.

				SCALE	DATE		
				NONE	5/06	JAT	JVW

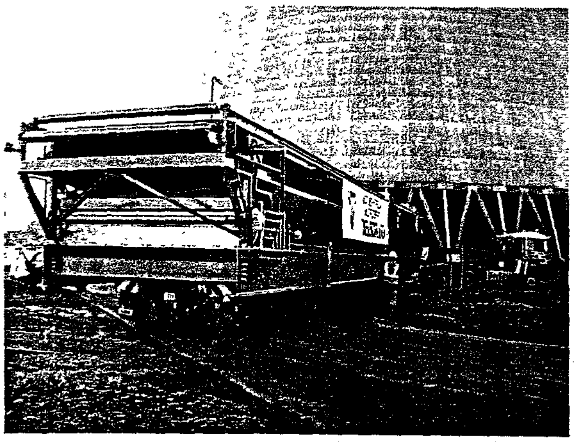
WESTECH | D102 | 061100 | 0

[redacted]

WESTECH
AN EMPLOYEE OWNED COMPANY

Furnished by:

WesTech Engineering, Inc.
3625 South West Temple
Salt Lake City, Utah 84115
(801) 265-1000 (Phone)
(801) 265 1080 (FAX)
Michael Gibson



Represented by:

Goble Sampson
3500 South Main, Suite 200
Salt Lake City, UT 84115
Contact: Mike Charnholm
Phone: (801) 268-8790
Fax: (801) 268-8792
E-Mail: mcharnholm@goblesampson.com

Proposal No. 061100

Prepared for:

Intermountain Power Service Corp
850 W. Brush Wellman Road
Delta, Utah 84625-9546

Project:

IPP
Gypsum Dewatering System Upgrade
Delta, Utah
Gypsum Dewatering System Upgrade

Equipment:

WesTech / Delkor Horizontal Belt Filters
And Ancillary Equipment

CONTENTS

- **Equipment Pricing**
- **Design Benefits**
- **Design Basis**
- **Equipment Description**
- **Clarifications**
- **Warranty**
- **Installation List**

1.0 EQUIPMENT PRICING

Two (2) 50% Horizontal Belt Filters 22.2m² filtration area, frame, pulleys, transporter belt, feed box, complete shop assembly, water slide belt support system, local control station, vacuum pump, filtrate pump, filtrate receiver, cake wash tank and pump;

Total for Two (2) 22.2m² Horizontal Belt Filter;	**US$1,265,000.00**
Freight to jobsite;	**US$18,800.00**
Field service (20 days);	**US$20,930.00**

Commercial Details

Price Validity: Prices are firm for a period not to exceed 30 days from date of proposal. Unless otherwise indicated, prices listed are for equipment only. Prices are shown in US dollars.

Equipment pricing will be firm through delivery in December, 2006.

Freight prices are based on diesel fuel at $2.75 per gallon. An adjustment will be made if prices exceed that level at time of shipment.

Sales Tax: No sales or use taxes or duties are included in our pricing.

Freight: Prices quoted are FOB factory with add for freight.

Equipment Payment Terms: Terms for equipment are 15 percent payment of the purchase price with GA submittal drawings, 35 percent upon receipt of major material in shop, and 50 percent net 30 days from notification of inspection or from shipment.

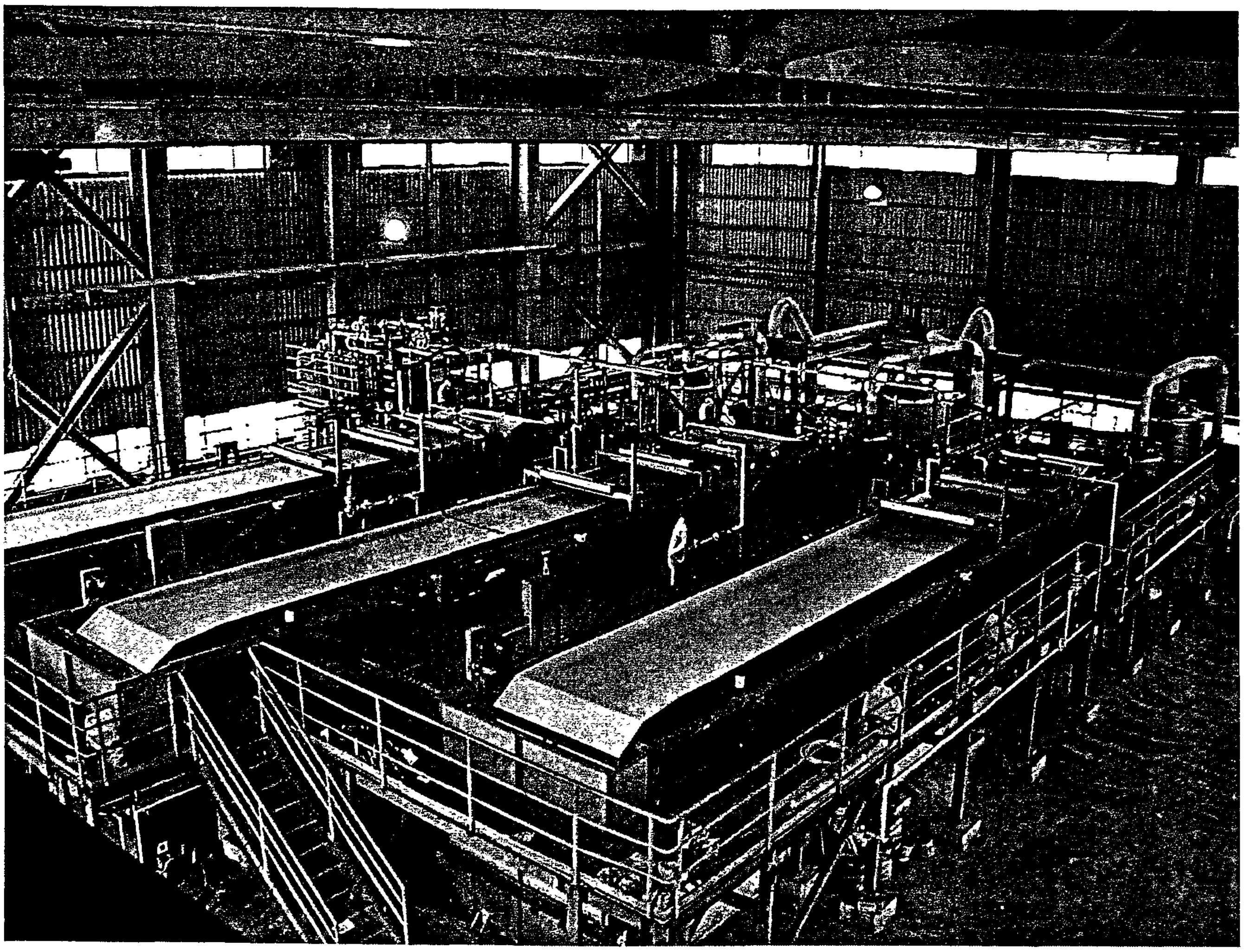
Schedule: Approval drawings will be submitted 6 to 8 weeks after receipt and acceptance of purchase order.

Shipment: Equipment will ship within 30 to 32 weeks after approved submittal drawings are received in our office.

Field Service: Twenty (20) days of field service is provided per plant as quoted above. Additional field service is available at $750.00 per day per person plus expenses.

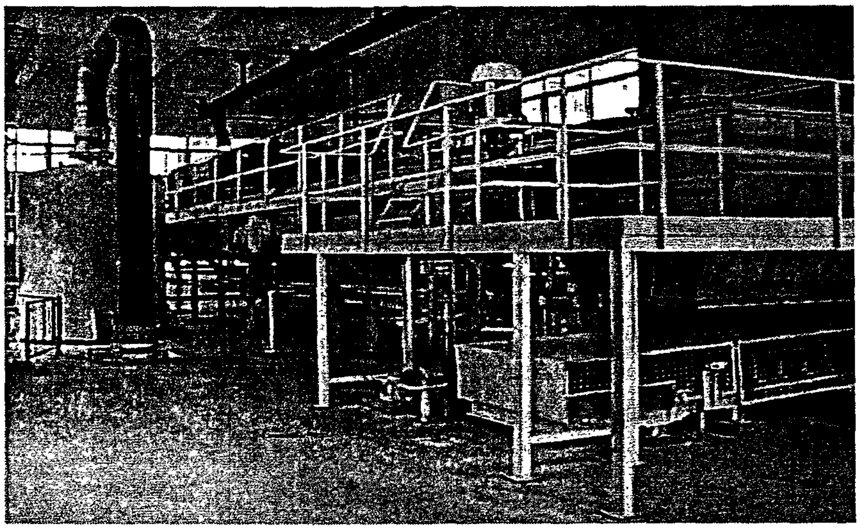
This proposal section has been reviewed for accuracy and is approved for issue:

By: Michael Dixon Date: March 17, 2006



2.0 DESIGN BENEFITS – Delkor Horizontal Belt Filters

Installation Experience	- Over 600 machines worldwide. - Total area >21,500 m^2. - Most experience with large belt filters. - World's largest belt filter (158 m^2). - World's fastest belt filter (60 m/min). - World leader in FGD. - 25 years FGD experience.
Heavy Duty, Dependable Design	- Channel/angle construction for corrosion protection. - Designed for heavy-duty service. - Vertically lowered vacuum box will not distort during movement. - Precision filter belt installation, conditioning and drilling. - USA based manufacturer.
Reduced maintenance	- "Delflex" concertina belt curbing handles deep slurry pools and reduces belt stresses which occur around the head / tail pulleys. - Wear belts with a polyester fabric sliding surface. - Vacuum receivers sized and designed to minimize vacuum pump corrosion. - USA based service capabilities.
Improved Dewatering / Washing	- Patented sloped filter design reduces short circuiting and leakage. - Sloping grooves ensure wash and filtrate flow freely and do not flood and mix together.



3.0 DESIGN BASIS

3.1 Introduction

Intermountain Power Service Corp has a requirement for two (2) horizontal belt filters for the IPP Gypsum Dewatering System Upgrade:

The following process feed conditions have been specified for each Horizontal Belt Filter:

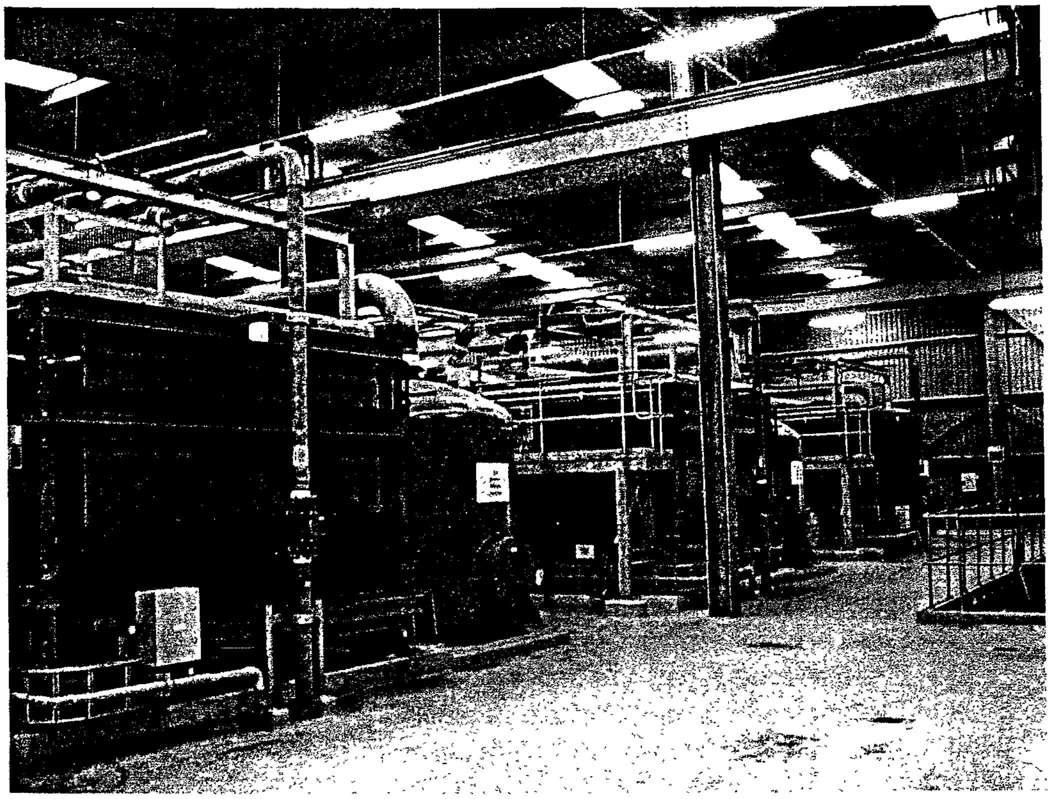
Filter Feed Slurry:	Slurry Mass Flow rate	40900	lb/hr
	Slurry Vol. Flowrate	127	gpm
	Solids Content (min.)	46	wt %
	SG	1.35	
	Temperature	130-140 (assumed)	°F
	pH	4-9 (assumed)	
Liquor	Chlorides	<9,000 (100 - 30,000 range)	ppm
Solids	Composition		
	$CaSO_4.2H_20$	to follow	wt %
	$CaSO_3$	to follow	wt %
	$CaCO_3$	to follow	wt %
	Inerts	to follow	wt %
Cake Wash Liquors	Composition		
	Temperature	110-120	°F
	Specific Gravity	1	
	pH	6 - 8 (assumed)	
Process Requirements	Solids Rate	40900	lb/hr
	Cake Moisture	10	wt %
	Cake Chlorides	<100	ppm

3.2 Filter Sizing

The filtration rate range to achieve 10 wt% cake moisture with cake washing is 160-180 lb/hr-ft². Each filter will be sized as follows:

Dry Solids Rate	40900	lbs/hr
Std. Filtration Rate	160-180	lbs/hr-ft^2
Std. Filtration Area per Unit	255-227	ft^2
Std. Filtration Area per Unit (Metric)	23.6-21.1	m^2
Closest Standard Size	22.2	m^2
Revised Filtration Rate	171	lbs/hr-ft^2

The WesTech/Delkor scope of supply is as per the attached process flow diagram. Enclosed is a general arrangement drawing reflecting design details of the horizontal belt filters.



4.0 EQUIPMENT SPECIFICATION

4.1 Introduction

The following specification is for model FRV31A WesTech / Delkor Horizontal Belt Filters with 2m belt width for FGD gypsum filtration and washing duty (if required).

The filters incorporate Delkor design features, which have been developed to meet the needs of the FGD and aggressive chemical industries over a number of years, including our most recent plants.

4.2 Materials of Construction

The equipment offered is supplied with process-wetted parts of:

- SBR rubber
- Polypropylene (PP) / ultra-high density polyethylene (UHDPE) (With steel backing)
- 254SMO (6% molybdenum austenitic stainless materials) or suitable equivalent
- FRP, PVC, CPVC
- Rubber lined mild steel

The parts not in contact with the process will be provided in the below materials:

- Epoxy painted mild steel, galvanized mild steel
- Machine steel
- SS304, SS316

4.3 Filter Frame

The filter frame will be manufactured using adequately sized and braced mild steel truss sections to maintain belt tension and assure total framework rigidity during transport, or during vibration under load conditions. The frame design will be sufficiently stiffened to take a full design load when the filter is in operation and full design load at start-up under operating vacuum.

The framework also supports:

- Head and tail pulleys
- Cloth and belt Roller
- The transporter belt and belt support system
- The vacuum box and lifting systems
- The cloth guiding and tensioning equipment
- The belt guiding and tensioning equipment
- The cloth/belt washing system
- The drive unit
- The deck items

4.4 Head and Tail Pulley

The Head (Drive) Pulley is supported by two self-aligning spherical roller bearings on the head frame. The shell is rolled in mild steel, and the steel stub shafts are attached to mild steel bosses (at both ends of the head pulley). One side is extended to support the shaft-mounted gearbox.

The pulley is rubber covered on the pulley face. The rubber lining terminates in a drip ring to prevent ingress of liquors into the bearings.

The head pulley is manufactured to a standard design, and the principal elements of the pulley construction are listed as follows:

End Plate Attachment	Mechanical connection to shaft – welded to drum
Diameter	32"
Degree of Crowning	Nil
Rubber Covering Thickness	3/8" Diamond pattern grooved

The 32" pulley diameter is recommended by our belt manufacturer to maintain the longest possible life for the belts. This diameter affects belt traction and affects the degree to which the belts are flexed as they are rolled on the pulleys. Larger pulleys also allow the filters to operate at higher than designed rates without excessive wear on the belts. Additionally, if service is required on the vacuum box, this size pulley provides maintenance personnel ample working area.

The tail pulley is manufactured to the same standard differing only in the bearing arrangement and stub shaft.

4.5 Belt and Cloth Return Rollers

The belt and cloth return rollers will be manufactured from rubber covered mild steel with high tensile steel shafts. The rollers are manufactured to Delkor standard design in which the shafts are keyed into mild steel bosses which prevents excessive bending and stressing of the material. Belt, cloth and tracking rollers are lined with natural rubber.

4.6 Transporter Belt

The transporter belt forms the nucleus of the filter. The belt is vulcanized in a press and maximum pressure is applied to ensure maximum ply adhesion, which is essential for long belt life. This ensures a dense rubber, which is free from blowholes and has excellent abrasion resistant qualities. WesTech / Delkor specify extremely accurate tolerances for the width, thickness and straightness of the belt. In this way WesTech ensures the following criteria are met:

- that belt - curbing interface is straight and hence edge vacuum leakage between the curb and the cloth is reduced
- that grooves are even in shape, depth and length as this is important for filtration.
- that the belt tracks straight and does not develop a "snaking effect".

The transporter belt has a cloth impressioned surface to assist with the drainage of filtrate, and it is essential to select an abrasion resistant rubber to ensure maximum life of this finish. A summary of the design features of the transporter belt offered is detailed below:

Width	2m
Overall Thickness	29mm
Top Cover	18mm
Bottom Cover	6mm
Carcass	4 ply woven polyester
Method of Belt Support	Slide Belt Support
Cloth impression	Included
Method of Joining	Shop Vulcanized Splice
Materials of Construction	SBR

The belt design includes a large mechanical safety factor to reduce stress. This is typically a factor of 32 between belt tensile strength and maximum operating stress load. The belt is designed to handle the hydraulic loads imposed on it by the process duty.

4.7 Curbs

The WesTech / Delkor filter design incorporates the patented Delflex ripple curbs 130mm high giving extra support in feed area but with flexibility over head and tail pulleys. The curbs are angled to assist in accurately positioning the cloth. This design of curbing offers significant advantages over straight curb, or uncurbed designs in that the life of the Delflex curbing is significantly longer.

4.8 Vacuum Box, Vacuum Seals and Lifting

The vacuum box is constructed in standard lengths (the spacing between intermediate supports) and is constructed in 254SMO (or equivalent). The vacuum box together with the vacuum seal water lines are easily raised and lowered. This lifting mechanism has adjusting screws to ensure that the vacuum seals are set at the correct height and are level. The adjusting screws are self-locking and ensure even distribution of longitudinal stresses to reduce vacuum box distortion.

The vacuum seal strips are machined from a UHDPE material. A water groove is machined into the sliding surface. This acts as lubrication feed for the seal water for the vacuum seals. The seal water acts as both a lubricant and a coolant for the seals and also forms a positive vacuum seal.

The design of the vacuum seal makes use of wear belts located between the main transporter belt and the stationary vacuum seal. The wear belts are supported by the seal strips, which are integral to the vacuum box assembly. These wear belts are easily replaceable by lowering the vacuum box. The replacement of the wear belts is a matter of 1-2 hours work. The wear belts are manufactured from a three-ply polyester carcass.

The filter design incorporates a pneumatically operated lifting mechanism for lowering and raising the vacuum box. A feature of the design is that the vacuum box is lifted vertically and the mechanism does not impart any twisting action to the vacuum box assembly. WesTech / Delkor's scope of supply includes the vacuum box lifting pressure regulator complete with integral isolation valve and pressure gauge, lifting control valve, lift rate needle valve, suitable painted steel cylinder, supply manifold and flexible airline.

4.9 Filter Belt Support

The main transporter belt is supported by a water slide fabricated from 304L stainless steel and bolted into position on the filter frame. Spillage gutters are included to prevent excess leakage.

4.10 Cloth Tracking

The tracking system consists of a standard cloth return roller set at a position where the cloth changes direction. This roller is mounted on a high-density polyethylene slide and is activated by a bellows assembly, coupled to a proportional control valve. The control valve is connected to a sensor paddle, which follows the edge of the filter cloth. This system enables proportional 'steering' of the cloth to ensure alignment. WesTech / Delkor includes a pressure regulator complete with integral isolation valve and pressure gauge. Inlet manifold materials are MS galvanized pipe, and flexible air tubing connects the regulator and control valve.

This cloth tracking system is fully proportional, automatic and designed so that no stress is put on the cloth fabric by sudden actuation of pinch rollers or similar devices. Wear on the edge of the cloth is minimized by careful design of the tracking sensor paddle. A counter-weighted cloth roller is positioned ahead of the tail pulley to provide dynamic tension on the cloth at all times. The location of this roller assures that the cloth is properly tensioned, as it joins the belt at the top of the filter, prior to slurry addition.

4.11 Transporter Belt Tensioning

The transporter belt tension and tracking is adjusted by the tail pulley which is mounted on a set of specially designed slide rails.

Automatic transporter belt tracking is NOT necessary on WesTech / Delkor belt filters.

4.12 Cloth Washing / Belt Washing

The filter cloth passes through a pair of cloth wash spray pipes, which are located in the discharge area. One spray pipe washes each side of the cloth. The cake-side spray is angled 45° to the cloth surface to flush solids from the cloth, and the non-cake side spray is perpendicular to cloth surface to flush solids from the cloth internal structure.

A belt spray is fitted on the grooved side of the transporter belt and is used to clean any solids that may have deposited in the grooves. This is used on a periodic basis as necessary.

The entire spray area is enclosed in a PP/MS/SS304 enclosure to minimize vapor and mist release to the environment.

The details of the spray pipes and requirements are as follows:

<u>Cloth Spray Pipe</u>		
Number of pipes	2	2 operating
Pipe Diameter	1-1/2	
Pipe Material	SS316	
<u>Belt Spray Pipe</u>		
Number of pipes	1	Intermittent cleaning
Pipe Diameter	1-1/2	
Pipe Material	SS316	

The spray nozzles offered have a plastic housing with a replaceable ceramic spray tip. It is important that the water supply to these sprays be kept free from suspended solids. This will maximize cloth life.

4.13 Bearings

All pulleys, cloth and belt rollers are supported by grease lubricated double roller bearings, fitted with lip seals designed to provide an L-10 rating of 100,000 hours.

4.14 Deck Items

All deck items are moveable for optimization of process performance. Support structures are in materials common with the main frame except where noted.

4.14.1 Feed Dam Roller

A polypropylene feed dam roller is included to form the cloth to the shape of the belt profile and minimize spillage of slurry from the rear of the filter. Its location is adjustable to control the filtrate solids content.

4.14.2 Slurry Feeder

Wetted parts of the slurry distributor are fabricated of high density polyethylene/254 SMO (or equal). The distributor position and angle are adjustable and the fishtail design ensures an even distribution of slurry over the full width of the filter.

4.14.3 Cake Wash Distributor

One (1) wash distributor is included per filter. Each distributor consists of a spray bar which disrupts the cake at the surface of the filter cake to improve dewatering as well as provide the necessary wash volume to remove soluble chlorides. Spent vacuum pump seal water is used as warm cake wash water in order to conserve water usage.

4.14.4 Cake Thickness Sensor

One Milltronics Miniranger Cake Thickness Sensor is included for measurement and control of the filter belt speed.

4.14.5 Speed Control

The filter belt speed control is effected by the Ultrasonic Cake Thickness Sensor linked to the plant DCS. The sensor is mounted on a moveable bracket so that performance can be optimized, and minimize process lag time and measurement of the feed pool, or "dry" cake thickness.

4.15 Safety Pull Switches / Emergency Stop Pullwires

WesTech / Delkor include emergency stop pullwires / pull switches for protection of plant personnel. These are located along the full length of the machine to ensure operator safety at all times.

4.16 Vacuum Control

WesTech / Delkor filters are designed to operate at up to full vacuum. Therefore, it is not necessary to provide any vacuum control protection, as is the case with other horizontal belt filters. Control of the vacuum level in the feed zone is not required if sufficient free, non-vacuum settling of the slurry is available.

4.17 Safety Guards

WesTech / Delkor offer minimum sufficient guarding to protect pinch points at the head and tail end of the filter.

4.18 Filter drive system

The recommended drive consists of a motor, controlled by an AC inverter to provide variable speed. It should be pointed out that the filter drive systems are very conservatively designed and there is considerable safety margin in the drive sizing. A summary drive specification for the filters offered is:

		Fastest Cycle	Normal	Slowest Cycle
Cycle Time	Seconds	60	120	360
Belt Speed	m/min	2	0	0
Absorbed Power	Hp	12.9		
Installed Power	Hp	15	0	0
Inverter Power	Hp	15	15	15

The scope for the drive system includes:

- Gearbox
- Motor to site standards
- AC frequency controller

4.19 Instrumentation

The filter has the following instrumentation included, which will be supplied to Delkor standard specifications:

4.19.1 Filter Seal Water Control

The filter is provided with a MS galvanized/PVC/SS316 manifold for supply of water to vacuum seal strips. A single flowmeter with low flow alarm switch is included for each:

- Vacuum Box Seal
- Cloth Belt Wash Manifold
- Belt Lubrication Water

4.19.2 Cloth Tracking

As described in Section 4.10.

4.19.3 Cloth & Belt Limit Switches

Switches are provided to shutdown the filter when cloth or belt lateral movement exceeds allowable limits. The travel switches are mounted on an adjustable bracket to control allowable movement. These will be wired into the filter alarm / stop circuit (by others). Additional switches can be mounted for provision of alarm notification for cloth / belt tracking or cloth tension. Below are the items that are included.

- Two (2) Cloth Tracking Trip Switches
- Two (2) Belt Tracking Limit Switches
- One (1) Cloth Tension Alarm / Trip

4.20 Filter Cloth

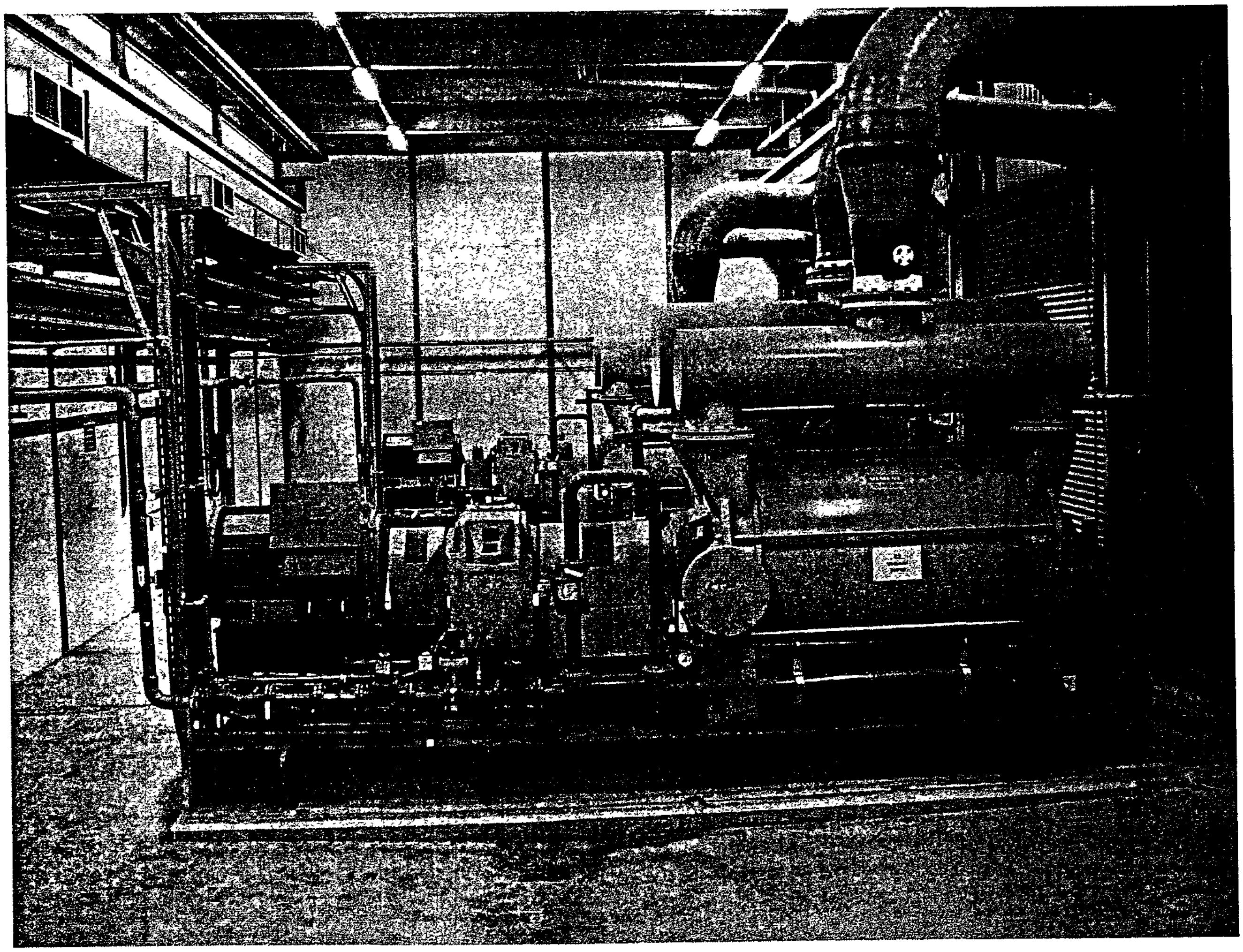
WesTech / Delkor only utilize filter cloths proven on particular applications.

One polyester monofilament filter cloth (PES6144, HE4570, HE 2765 or similar) with a Hastelloy clipper seam joint will be supplied with each filter. Cloth life of over one year has been achieved on some Delkor belt filters operating in this application. On this size filter the expected cloth life will be 6 to 9 months.

Filtrate suspended solids of less than 3,000 ppm are normal with less than 1,000 ppm possible in some cases.

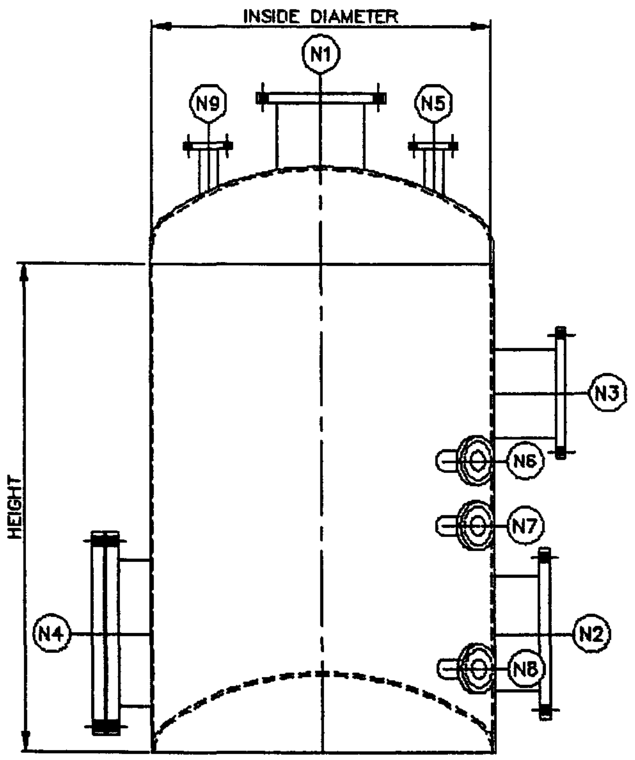
4.21 Filter Ancillary Equipment

Ancillary equipment is included as per subsequent sections. All quantities are per filter. Requirements for additional components to complete a working installation are indicated. All materials and painting specifications will adhere to the statements in Section 4.2.



4.22 Filtrate Receivers

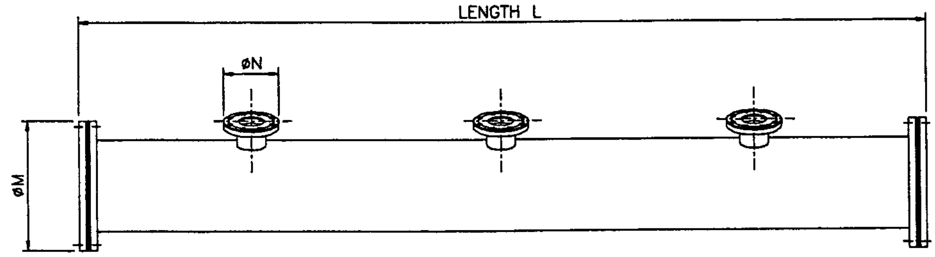
One filtrate receiver is offered per filter. The specification of this receiver for each size filter offered is as below. The receiver will be provided with a site glass, vacuum gauge and isolation valve. The receiver will be designed to bolt directly to the floor.



Material of Construction		Rubber Lined Steel
Inside Diameter		72"
Straight Height		108"
Design Code		Full Vacuum
Flange Specification		150# ANSI Std.
Nozzle No.	Description	Size
N1	Gas Outlet	18"
N2	Filtrate Outlet	15"
N3	Gas Inlet	20"
N4	Manhole (if required)	24"
N5	Instr. – Pressure Gauge	2"
N6	Instr. Vibrating Fork – HH Level	2"
N7	Instr. Vibrating Fork – High Level	Not Required
N8	Instr. Vibrating Fork – Low Level	Not Required
N9	Instr. – Conductivity Level Probe	Not Required
Filtrate Discharge Mechanism		Filtrate pump

4.23 Filtrate Manifolds and Hoses

One filtrate manifold will be connected to the vacuum box with filtrate hoses. Piping from the manifold to the receiver will be by others.



Material of Construction	FRP
Diameter of Manifold (ϕM)	20"
Length of Manifold (L)	42' Nominal
Diameter of Hoses (ϕN)	4"
Design Code	Full Vacuum
Flange Specification	ANSI
No. of Hoses	12
Hose Material	SBR
Hose : Manifold Coupling	PP Flange
Hose : Box Coupling	Hose stub
Hose Clamp Material	SS316

4.24 Vacuum Pump

One liquid ring seal vacuum pump per filter will be supplied to the following specification.

Duty	4000	CFM
Number of Pumps	1	Per Filter
Ambient Pressure	13.5	Psi
Vacuum Level	20	In Hg
Ambient Temperature	75	°F
Gas Temperature	110	°F
Seal Water Temperature	75 (assumed)	°F
Seal Supply Pressure	15	Psig
Site Elevation	4630	Ft above sea level
Seal Recycle	no	
Seal Water Consumption	42	Gpm
Absorbed power	197.5	Hp
Installed power	250 / 480	Hp / v
Manufacturer	NASH or Equivalent	
Noise Level	<85	dB(A) at 1m in a free field environment
Scope of Supply		**Materials**
Pump	Yes	CD4MCu
Baseframe	Yes	MS
Drive system	Belt Drive	MS
Motor	Yes	Vendor standard (As option)
Seal supply Manifold	Yes	MS
Seal Supply Instrumentation	Pressure Gauge, Low Flow Switch	
Inlet / Discharge Separator	Yes	MS
Silencer	Yes	MS

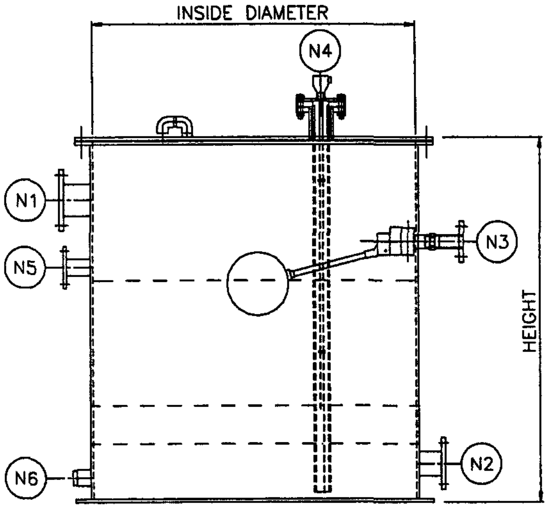
4.25 Filtrate Pump

One (1) filtrate pump per receiver will be supplied to the following specification for all plants:

Duty	135	Gpm
Number of Pumps	1	Per Filter
Ambient Pressure	13.5	psi
Ambient Temperature	75	°F
Gas Temperature	110 (assumed)	°F
Filtrate Temperature	140 (max)	°F
Suction Conditions		Flooded Barometric Discharge
Seal Supply Pressure	15	psig
Site Elevation	4630	Ft above sea level
Pump Discharge Head	80	Ft water
Absorbed power	5.5	Hp
Installed power	10	Hp
Manufacturer	Krogh	
Noise Level	<85	DB(A) at 1m in a free field environment
Scope of Supply		**Materials**
Pump	Yes	MSRL or C276
Baseframe	Yes	MS
Drive system	V-Belt	MS
Motor	Yes	Vendor standard
Seal supply Manifold	Yes	MS
Seal Supply Instrumentation	Pressure Gauge, Low Flow Switch	

4.26 Cake Wash System

WesTech / Delkor includes a skid mounted Cake washing system for each horizontal belt filter as detailed below. Each skid will include a storage tank and pump. Each cloth wash tank will collect spent vacuum pump seal water for cloth washing and second stage cake washing. Each pump comes complete with baseplate, coupling and guarding.



CLOTH / CAKE WASH TANK

Material of Construction		Epoxy Coated Mild Steel
Inside Diameter		60"
Height		72"
Nozzle No.	Description	Size
N1	Seal Water Inlet	2"
N2	Cloth Wash Water Outlet	2 x 2"
N3	Make Up Water Inlet	1"
N4	Instrument – Level Probe	2"
N5	Overflow	8"
N6	Drain	2" NPT

CLOTH / CAKE WASH PUMP

Duty (each)	30	gpm
Number of Pumps	1	Per skid
Ambient Pressure	13.5	"Hg
Suction Conditions	2	Ft flooded
Discharge Head	130	Ft
Site Elevation	4630	Ft above sea level
Absorbed Power	3.2	Hp
Installed Power	5	Hp
Manufacturer	Peerless or Equivalent	
Pump type	Horizontal	
Noise Level	<85	dB(A) at 1m in a free field environment
Scope of Supply		Materials
Pump	Yes	MS Body, Nodular Cast Iron Impeller
Baseframe	Yes	MS
Drive system	Direct Drive	MS
Motor	Yes	Vendor standard
Sealing System	Mechanical - Unflushed	

4.27 Control / Instrumentation

4.27.1 Control

The belt filter will be controlled by a plant-wide DCS system (supplied by others). WesTech / Delkor will provide local junction boxes for connection of local instruments and control devices to the DCS.

Panels:

- Horizontal Belt Filter Panel – 60" X 36" NEMA 4X SS panel with 15hp VFD
- Filtrate Panel – 8" X 6" NEMA 4X SS panel
- Vacuum Pump Panel – 8" X 6" NEMA 4X SS panel
- Cloth / Cake Wash Panel – 8" X 6" NEMA 4X SS panel

4.27.2 Instrumentation

Vacuum Pump -	Local pressure indicator and in-line strainer are included on the vacuum pump seal water inlet.
Cloth Wash Tank -	Low-level switch with alarm is included in the cloth wash tank, this will protect the cloth wash pump from running dry in the event of low level occurring. A high level switch with alarm is also included.
Filtrate Receiver -	High-level alarm and vacuum pressure indicator are included per receiver.
Cloth Wash Supply -	Pressure gauge is included in the cloth wash supply.
Cake Thickness Detector -	Ultrasonic cake thickness detector is included. All other instrumentation is indicated on WesTech / Delkor P&ID drawing.
Vacuum Box Seal Water -	Flowmeter with low flow alarm is included on each vacuum box seal water pipeline.

4.28 Wiring and Junction Boxes

Wiring of instruments and drives to local junction boxes is included for each Belt Filter assembly, Vacuum Pump skid, Vacuum Receiver/Filtrate Pump, Cloth Wash Skid and Cake Wash Pump skid.

4.29 Drip Tray and Collection Hopper

We have excluded the drip trays and cloth wash collection hoppers. These concrete items should be included in the building civil work.

4.30 Painting Specification for Steelwork

All mild steel structural members are to be sandblasted to SSPC-SP10 (near white blast) and painted with one (1) coat of Carbozinc 11 primer (2-3 mils DFT), one (1) intermediate coat of Carboline 893 epoxy (4-6 mils DFT) and one (1) final coat of Carboline 134 polyurethane (2-3 mils DFT). All drive, bearing housings, and motors received with their manufacturer's protective paint. All stainless steel will not receive surface preparation or painting.

4.31 Start-Up / Commissioning Spare Parts

Commissioning parts will consist of one spare filter cloth. This is included in the base price.

TABLE 1
MAIN COMPONENTS

Equipment Assembly	Dimensions	Shipping Weight
Horizontal Belt Filter	55' X 10' X 7'	40,000 lbs
Vacuum / Filtrate Receiver	6' Dia X 10 Tall	3,000 lbs
Vacuum Pump Skid	15' X 8' X 8'	15,000
Cake / Cloth Wash Tank and Pump	12' X 6' X 7'	6,000

TABLE 2
MATERIALS OF CONSTRUCTION

	Item	Material	Thickness	Lining Material	Lining Thickness
	Filter Cloth	Polyester	N/A	N/A	N/A
	Filter Belt	SBR	28 mm	N/A	N/A
	Filter Belt Support	304 SS	As Req.	N/A	N/A
	Vacuum Box	254 SMO (or eq.)	1/8"	N/A	N/A
	Wear Strips	UHDPE	2-1/4"	N/A	N/A
	Wear Belt	EPDM/Polyester	¼"	N/A	N/A
	Feed Box	254 SMO/UHDPE	3/16"	N/A	N/A
	Wash Box	316 SS	As Req.	N/A	N/A
	Cloth/Belt Wash Header	316 SS	-	N/A	N/A
	Frame	Steel	As Req.	Paint	N/A
	Drip/Drainage Pan	Concrete-Others	N/A	N/A	N/A
	Rollers & Pulleys	Steel	As Req.	Natural Rubber	¼" – 3/8"
	Filtrate Pump Casing	CD4MCu	N/A	N/A	N/A
	Filtrate Pump Impeller	CD4MCu	N/A	N/A	N/A
	Receiver	Steel	3/8"	Natural Rubber	¼"
	Vacuum Pump	Cast Iron	N/A	N/A	N/A
	Vacuum Pump Piping	FRP	As Req.	N/A	N/A
	Filtrate Piping	FRP	As Req.	N/A	N/A
	Wash Piping	316 SS	As Req.	N/A	N/A
	Misc. Piping	Steel, PVC	As Req.	N/A	N/A
	Vacuum Pump Silencer	Steel	N/A	N/A	N/A

TABLE 3

UTILITY CONSUMPTION DATASHEET

1. ELECTRICAL

Power consumption per belt filter will be as below.

EQUIPMENT	ABSORBED POWER (Hp)	INSTALLED POWER (Hp)
Filter Drive Motor	12.9	15
Vacuum Pump Motor	197.5	250
Cake / Cloth Wash Pump Motor	3.2	5
Filtrate Pump Motor	5.5	10
TOTAL	**219.1**	**280**

2. COMPRESSED AIR

Filter Cloth Tracking	1.5 CFM free air at 29 psig normal
Vacuum Box Lifting	3 CFM free air at 75 psig maintenance
Automated valves	1.5 CFM at 75 psig intermittent

3. WATER

DUTY	SUPPLY PRESSURE (psig)	NORMAL (gpm)	MAXIMUM (INTERMITTENT) (gpm)
INPUT TO SYSTEM:			
Vacuum Pump Seal Water (Fresh)	15	42	57
Cloth Wash Water (Fresh)	45	30	0
Vacuum Box Seal Water (Fresh)	11	9	9
Belt Slide Water (Fresh)	11	12	
Cake Wash Water (Spent Vac Pump Seal Water)		26	30
Excess Spent Vac Pump Seal Water		16	27

Note:

- Above motor sizes, air and water quantities are provisional and subject to change following confirmation of plant layout.

5.0 CLARIFICATIONS AND EXCLUSIONS

Exclusions

Items NOT INCLUDED in WesTech's Bid to be PROVIDED BY CLIENT (including the following except as noted above):

- Unloading, storage or installation.
- Floors, foundations, anchorage, or concrete work (GA's and loadings by WEI)
- Piping, valves, and fittings to and from the platform or filter
- Field painting or welding
- Service connections
- Lubricating oil or grease
- Field wiring or conduit
- PLC controls
- Interconnecting wiring
- Filter feed pumps
- Seal water pumps
- Feed flow meter
- Feed density meter
- Drip trays
- Slurry spillage deckles
- Steam hoods
- Fume hoods
- Chemicals
- Motor starters
- Pressure relief valves
- Discharge chutes and conveyors
- Insulation and cladding
- Emergency power supply.
- Lighting for erection and for permanent installation.
- Drain pipe work, hoppers or hoses.
- Power, water and air required to carryout the erection work.
- Instrumentation other than specified in proposal
- Pneumatic air supply or pipe work
- Oils and lubricants.
- Automatic or central greasing system.
- Customs clearance, local duties and taxes.
- Electrical controls (i.e. MCC for filter and ancillaries) other than specified.
- Any civil works.
- Access platforms
- Any item or service not specifically detailed in our proposal.
- Interconnecting pipe work

Quality Assurance Program

WesTech prides itself on its quality products and customers. Recognizing the importance of continuous improvement, WesTech has developed a quality management system in order to meet our customer's needs for exceptional quality and service. This system is based on, and complies with, the International Organization for Standardization's ISO-9001-2000 standard, and its technical U.S. equivalent ANSI/ASQC Q91. WesTech is certified by SGS in meeting this standard.

6.0 WARRANTY

Performance Warranty

WesTech Engineering, Inc. warrants that each Delkor horizontal belt filter offered in WesTech Proposal Number 061100 will, when installed, operated, and maintained in accordance with WesTech's instructions, and when fed with the process stream described by Jim Wilhelm of Codan Associates, will produce dewatered filter cakes averaging 10 wt% moisture and <100 ppm chlorides.

In the event that the above performance criteria are not met, WesTech will conduct standard vacuum leaf tests at the plant site using a portion of the feed from the full-scale horizontal belt filters. The warranted filtration rate will then be the lesser of the above specified rate or eighty (80) percent of the leaf test rate and the cake solids content will be the lesser of the above specified moisture content or two percentage points less than the value predicted from the leaf test.

Acceptance tests must be performed within sixty (60) days after initial start-up of the equipment and, if the warranted performance is not obtained, then WesTech is to be notified within ten (10) days. WesTech shall then have the right - and if requested by the customer, the obligation - to visit the installation to determine the cause of such failure. It is a condition of this warranty that the customer will, at its expense, cooperate with WesTech in the making of further tests and make available necessary personnel, feed, and operating conditions to enable WesTech to conduct such tests.

If the failure to attain warranted performance is due to purchaser's fault in installation or operation or in not providing proper feed or other specified operating conditions, then customer shall pay the living and travelling expense of WesTech personnel visiting the installation and in addition, shall pay the sum of US$750.00 per man day or fraction thereof of such personnel. Nevertheless, such personnel will, on request, work with customer, at customer's expense, in making necessary corrections to accommodate the changed conditions.

If failure to attain warranted performance / equipment availability is due to defect in WesTech equipment, then WesTech will, at its expense, provide on site operating assistance as required and/or make such changes or modifications in the equipment or its operation as WesTech deems necessary until such performance is attained, or a percentage, not to exceed (5) percent of the purchase price of the equipment, been expended. If it is deemed by both parties, after good faith efforts by both parties to attain warranted performance, that the warranted performance levels cannot be attained, the customer may at its option elect to be credited with a percentage of the purchase price of the equipment failing to perform based on mutually accepted criteria, as long as the total of expenditures and credit do not exceed 5 percent of the purchase price.

This warranty shall be fully satisfied and WesTech discharged there from upon the earlier of: a) attaining warranted performance over an 8 hour period, b) expiration of 60 days following initial start-up with no tests being made, c) WesTech refunding or tendering refund of a portion of the purchase price or expending such amount in performance hereunder, or d) the expiration of 6 months following shipment of the equipment.

By purchase of the equipment, purchaser agrees that the obligations of WesTech and remedies of purchaser as expressed in this warranty are exclusive and purchaser expressly waives any and all other warranties including warranty of merchantability and fitness for particular purpose, whether written, oral, express, implied, or statutory, and WesTech has no liability for any consequential damage or loss of time or any other expenses, costs or damages whatsoever, other than as expressed above or contained in WesTech's written warranty against deflects in material and workmanship.

WESTECH

WARRANTY

WesTech equipment is backed by WesTech's reputation as a quality manufacturer, and by many years of experience in the design of reliable equipment.

Equipment manufactured or sold by WesTech Engineering, Inc., once paid for in full, is backed by the following warranty:

For the benefit of the original user, WesTech warrants all new equipment manufactured by WesTech Engineering, Inc. to be free from defects in material and workmanship, and will replace or repair, F.O.B. its factories or other location designated by it, any part or parts returned to it which WesTech's examination shall show to have failed under normal use and service by the original user within one (1) year following initial start-up, or twenty-four (24) months from shipment to the purchaser, whichever occurs first. Such repair or replacement shall be free of charge for all items except for those items such as resin, filter media and the like that are consumable and normally replaced during maintenance, with respect to which, repair or replacement shall be subject to a pro-rata charge based upon WesTech's estimate of the percentage of normal service life realized from the part. WesTech's obligation under this warranty is conditioned upon its receiving prompt notice of claimed defects, which shall in no event be later than thirty (30) days following expiration of the warranty period, and is limited to repair or replacement as aforesaid.

THIS WARRANTY IS EXPRESSLY MADE BY WESTECH AND ACCEPTED BY PURCHASER IN LIEU OF ALL OTHER WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WHETHER WRITTEN, ORAL, EXPRESS, IMPLIED, OR STATUTORY. WESTECH NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER LIABILITY WITH RESPECT TO ITS EQUIPMENT. WESTECH SHALL NOT BE LIABLE FOR NORMAL WEAR AND TEAR, CORROSION, OR ANY CONTINGENT, INCIDENTAL, OR CONSEQUENTIAL DAMAGE OR EXPENSE DUE TO PARTIAL OR COMPLETE INOPERABILITY OF ITS EQUIPMENT FOR ANY REASON WHATSOEVER.

This warranty shall not apply to equipment or parts thereof which have been altered or repaired outside of a WesTech factory, or damaged by improper installation, application, or maintenance, or subjected to misuse, abuse, neglect, accident, or incomplete adherence to all manufacturer's requirements, including, but not limited to, Operations & Maintenance Manual guidelines & procedures.

This warranty applies only to equipment made or sold by WesTech Engineering, Inc.

WesTech Engineering, Inc. makes no warranty with respect to parts, accessories, or components purchased by the customer from others. The warranties which apply to such items are those offered by their respective manufacturers.

INSTALLATION OF TWO (2) HORIZONTAL BELT FILTER AND ANCILLARY EQUIPMENT AS FURNISHED BY WESTECH TO INCLUDE:

Provide all supervision, labor, cranes and miscellaneous tools required to receive, set and install:

Two (2) WesTech furnished Belt Filters
Two (2) Filtrate Receivers
Two (2) Filtrate manifolds and Hoses
Two (2) Vacuum pumps
Two (2) Filtrate Pumps
Two (2) Cake Wash Systems (Tank and Pump)
Required Controls for connection to existing PLC
Required Instrumentation
Required Power wiring to existing MCC or connection point.
Required Interconnection piping to include Air, Seal Water, Vacuum, Cloth Wash, Service Water, Drains (above ground only) and Filter Feed. Maximum distance from filter of any system is estimated at 50 feet.

Furnish and install Concrete Two (2) Belt Filter Equipment Pads with central drain area.

HORIZONTAL BELT FILTER ACCESS WALKWAYS:

WesTech proposes to furnish and install one complete Platform Access and Walkway to include:

Design layout per WesTech drawings (platform to run between Belt Filters and across one end with, access stair at one (1) point and access ladder at one (1) point
Platform is constructed of C8 Channel mainframe with I4Beam Column Supports.
Platform structure is painted two coats epoxy.
Platform deck is IKG Industries W/B 1-1/4" x 1/8" galvanized Grating or equal.
Stair treads are non-slip galvanized.
Hand rail for complete platform perimeter is a 1-1/2" steel tube two rail system, painted safety yellow with two coats epoxy.
Platforms will be shipped in most shippable sizes ready for field assembly.

Budget Price $520,000.00

WESTECH
3625 South West Temple, Salt Lake City, Utah 84115 Phone (801) 265-1000

TO: Codan Associates

FROM: Neal Smith

ATTN: Jim Wilhelm

PROPOSAL NO: 061100 GROUP: 17

SUBJECT: 12' X 18' Rotary Drum Vacuum Filter Retrofit

PROJECT NAME: IPSC

CC: Roger Summerhays

DATE: May 5, 2006

WesTech Engineering, Inc. is pleased to submit pricing to retrofit three (3) rotary drum vacuum filters located at Intermountain Power Service Corp. in Delta, Utah. The retrofit for each machine includes the following:

- 2" CPVC internal drum piping.
- Rubber lined steel agitator mechanism with reducer, coupling and 5 hp motor.
- 316 stainless steel wash pipes and nozzles.
- Bearings, bushings, couplings and gaskets.
- Filter cloth and caulking.
- Plastic grids and rubber division strips.
- Drum drive and 5 hp motor.
- 72" diameter X 84" tall rubber lined vacuum receiver.
- Rubber lined filtrate pump and 10 hp motor.
- 4500 cfm vacuum pump with 300 hp motor.
- Scraper mechanism with UHMWPE blade.
- Drum valve and trunnion bearing assemblies.
- Guards

BUDGET PRICE $ 850,000.00

WESTECH
3625 South West Temple, Salt Lake City, Utah 84115 Phone (801) 265-1000

BUDGET PRICE TERMS & CONDITIONS:

Sales Tax: No sales taxes, use taxes, or duties have been included in our pricing.

Delivery: Retrofit of drum filters to be completed upon a mutually agreed upon schedule after acceptance of purchase order.

Field Service: Mechanical checkout and startup is available by our factory field service engineer at $750.00 per day.

We appreciate the opportunity to provide this budget proposal.

By: Date: May 5, 2006

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